The Life Histories of certain Moths of the Families Ceratocampidæ, Hemileucidæ, etc., with Notes on the Armature of the Larvæ.

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Family Ceratocampidæ.

Judging by the larvæ alone, this group is well circumscribed. The most generalized forms are Dryocampa and Anisota. In these there is no "caudal horn," and the single median dorsal spine on the ninth abdominal segment in Dryocampa is about one-third as long as that of Anisota, while in Sphingicampa the spine is reduced to a minimum. That the larva of Dryocampa is the simplest of the family is also shown by the fact that the two rudimentary spines on the third thoracic segment are shorter and less forked, and the other abdominal spines are shorter than in the other genera.

The suranal plate has the shortest spines in Sphingicampa and longest in Anisota, being of a length intermediate between these two genera in Dryocampa, in which, however, they are still long.

Sphingicampa may be regarded as a transitional form connecting Dryocampa and Anisota with Eacles and Citheronia.

Eacles in its first larval stage, as compared with that of Sphingicampa, differs in the following respects:

The prothoracic segment is armed with spines; the thoracic spines are in Stage I forked at the end; the caudal horn is much longer and slenderer, and also forked at the end; also there is a single median spine on the ninth abdominal segment. Eacles is peculiar in the abdominal segments being marked with two black transverse stripes.

Aglia tau, a connecting link between the Ceratocampidæ and Saturniidæ and the type of a new subfamily, Agliinæ. In this European Bombycine moth we have surviving, side by side with the generalized Saturnia, a most interesting form, which is a Ceratocampid in its earlier larval stages, the larva in its last stage and the moth being very near the Saturnians, although it does not spin a cocoon, and should be regarded as a Ceratocampid. We could not have any clearer demonstration of the origin of one family from another by direct genetic descent.

The transformations of this form, originally figured in Duponchel et Guénée's *Iconographie** (Tome ii), has been more fully elaborated by Mr. Poulton.

Having received, through the kindness of Dr. Heylaerts, a young larva of *Aglia tau* in its third stage, I have been able to compare it with *Eacles*

* Guénée states that after attaining its full size: "Elle se retire à la surface de la terre, entre des mousses et des débris de végétaux qu'elle attache avec de la soie, et elle s'y change en une chrysalide grosse, courte, d'un brun foncé saupaudré de grisâtre, et dont l'anus est terminé par une faisceau de pointes recourbées."

imperialis in its third stage, a thing Mr. Poulton could not do for want of specimens. The resemblance between the two genera at this stage is most striking, although the fully fed larvæ are so different, Aglia passing at a single molt (the third and last, this larva only having *four* stages), from one family to another! We know of no parallel case, or at least of one so very striking and conclusive.* Thus the ontogenetic development of this caterpillar epitomizes that of two families, whereas that of most Bombyces is simply usually only an epitome of that of a subdivision of a family, or of a small group of genera.

Aglia tau in its third stage differs from *Eacles imperialis* in its third stage in having a pair of dorsal "horns" on the first and third thoracic segments, where *E. imperialis* has only minute ones on the prothoracic segment, while those on the second thoracic segment are as well developed as those on the third segment; those on the second segment are minute; all the "horns" are forked as in Eacles. The dorsal spines on the abdominal are simple and minute, like those on the second thoracic segment. The shape of the head and of the anal legs is much as in Eacles, but the suranal plate differs strikingly in being produced into a rather large, spinulated spine, a feature not known to exist in any Ceratocampids.

It should be observed in regard to the large size of the prothoracic horns of Agiia, that those of *Citheronia regalis* are quite well developed, being about two-thirds as long as those on the two succeeding segments.

Upon examining the adult of Aglia, I find that its head and antennæ are closely similar to those of *Hyperchiria io*, and the Hemileucidæ in general; the antennæ form a close approach to those of *H. io*, as on careful examination with a good lens a second branch of the pectinations of the male antennæ can be perceived; it forms a long, separate branch, but is in the dead and dry specimens very closely appressed to the anterior main pectination. In the venation of both wings Aglia shows a most unexpected resemblance to that of *Eacles imperialis;* like that and other Ceratocampidæ and the Hemileucidæ, having five subcostal branches, while in the Saturniidæ there are only four, the first one wanting in the latter family.

Thus the moth belongs with the Ceratocampidæ, while the larva after the last molt loses all its spines and becomes very much like a Saturnian, perhaps of the type of Telea, though it is without tubercles or spines, and especially like a smooth form, the larva of *Attacus betes* Walker, figured by Burmeister in his *Atlas of the Lepidoptera of the Argentine Republic.* We therefore suggest that *Aglia tau* should be regarded as the type of a distinct subfamily of Ceratocampidæ, and thus the latter group may be divided into the two subfamilies, Ceratocampinæ and Agliinæ.

* Over twenty years ago, in 1863, when first beginning my studies on the Bombyces, my attention was attracted to the singular changes of *Aglia tau* and I compared the young larva to the full-grown larva of *Citheronia regalis* and pointed out that the latter genus was an "embryonic form and therefore inferior in rank to the Tau moth" (*Amer. Naturalist*, June, 1870, and *Our Common Insects*, 52).

At present both from their larval and their imaginal characters, and in their spinning a cocoon we are disposed to consider the Hemileucidæ as a family closely allied to, though distinct from, the Ceratocampidæ.

On examining the European genus Endromis, we are disposed to think that the family Endromidæ is a natural one. It would, however, be a violation of the principles of classification to include Aglia with it. The two genera, both as regards their larval and their adult characters, are quite distinct. I find that *Endromis versicolora* has the head, palpi and antennæ and the hairy abdomen very closely like those of our *Hemileuca maia*, but the median vein of both wings divides into four branches, and the subcostal vein of the four wings divides into five branches, as in *H. maia* and the other Hemileucidæ. Judging by the colored figures of the larva in European works, the larva of Endromis is smooth, with a small retractile head, oblique bars, and a conical caudal horn. The group Endromidæ is a branch of the Bombycine tree, parallel to but distinct from the Hemileucidæ, and stands above the latter, connecting the group and the Ceratocampidæ and Saturniidæ with the higher families of the Bombyces, in which there are four branches of the median vein, all the families mentioned agreeing with the Notodontidæ in having but three. In its general shape, the small retractile head, the mode of coloration, and the caudal horn, the larva of Endromis appears to be remarkably near the Sphinges. Buckley describes the cocoon as "composed of an open-worked reticulation of coarse black or black-brown silk threads, with round or broad oval interstices, as the fabric is extremely strong, tough and elastic, covered externally with moss and birch leaves firmly adherent" (iii, 65).

It is interesting that in the transformations of *Rhescynthis erythrinæ*, as figured by Burmeister, we have a parallel to the case of *Aglia tau*. The fully grown larva is smooth-bodied and without the four long large thoracic spines, and the caudal horns on the eighth and ninth abdominal segments of the previous stage. The genus appears to belong to the Ceratocampidæ.

Although we are not yet acquainted with the early larval stages of Endromis, we do not see why the Sphingidæ may not have sprung from a form like this as much as from Aglia, as the shape and markings of the full-grown caterpillar are much nearer a typical Sphinx than those of Aglia. Moreover, taxonomically, Aglia is by no means so "closely" allied to the Sphingidæ as Mr. Poulton in his able papers would lead us to infer. In its venation Endromis is much nearer, and the latter is a more generalized or synthetic form than Aglia. From the Ceratocampidæ the families of Saturniidæ and also of Hemileucidæ may have originated, and indeed all the Bombyces, unless we except the Arctians and Lithosidæ, may have evolved before the Sphingidæ appeared. Judging by the characters of the head, the antennæ, thorax, and especially the venation, the Sphingidæ are far removed from the Ceratocampidæ, and their origin from the latter family was at least remote, and there must be some lost, extinct annectant forms which originally connected them.

The Life History of Dryocampa rubicunda (Fabr.).

The unfertilized eggs laid in New York, July 15, were kindly sent me by Mr. James Angus, but they did not hatch.

Egg.—Length, 1.4 mm. Oval, a little flattened; the shell yellow, thin, parchment-like, the surface smooth, polished, under a one-half inch objective showing no traces of pits or polygonal areas. The shell is so thin that unfertilized eggs collapse irregularly.

Larva Stage I and II.—The larva was found at Providence by Mr. Bridgham about June 20. The following description is drawn up from his excellent colored figures. He says it molts in a day after hatching, and after the molt the larva is the same as before, except that the general color of the body is a little darker, so that the following description will provisionally apply to both stages.

Length, 5 mm. The head is rather large, rounded, no wider than the body, and deep black. The body is of the same width throughout to the ninth abdominal segment. The prothoracic segment a little wider than the rest of the body. From the second thoracic segment arises a pair of thick large horn-like tubercles, which are about as long as the thickness of the segment bearing them; they are greenish at the base and black beyond; the end is blunt, not tapering at all, giving rise to a hair on each side of the end. All the tubercles on the other segments are in the form of small, simple acute spines of nearly uniform size, those on the prothoracic segment being of the same size as those behind the succeeding segment. There are three rows of spines on each side of the body, and the dorsal ones are no larger than those of the subdorsal and subspiracular series. On the eighth abdominal segment there are two widely separate dorsal spines, and two shorter ones on the ninth segment. The body is pale yellowish green, with a median dorsal and a subdorsal dark-green stripe, also a distinct lateral ridge low down, from which the infraspiracular spines arise. The next stage was drawn June 25, "after second molt."

Stage II (?).—Length, 7 mm. The head is now smaller in proportion than before, but still black. *The two horns are now shorter than before* in proportion to the body, but otherwise the same; the other spines are slightly stouter. *The six lines are now reddish, as is the lower (infraspiracular) side of the body.*

Five caterpillars were found feeding side by side on the under side of a red maple leaf, August 12, at Brunswick, Me. They do not start when irritated or use their horns.

Stage III (?).—Length, 8-9 mm. Head rounded, scarcely as wide as the body, very dark chestnut to nearly black. Body cylindrical, not so much flattened as in Anisota. On the first thoracic segment, which is slightly narrower than the second, are two rounded black flattened conical tubercles, not piliferous, and two smaller flatter ones behind. Two larger subtriangular subdorsal black tubercles give rise to three minute short hairs. On the second thoracic segment are two long subdorsal black

spines tapering to the end, which is slightly forked and setiferous, and the spines are minutely spinulated; the two horns are about two-thirds as long as the body is broad. They are represented on the third thoracic segment by two minute conical black tubercles, the homologous ones on the abdominal segments being minute and greenish, tipped with black. Those on the sides of each segment are larger, acutely conical and black. On the eighth abdominal segment are four conical black tubercles, two dorsal and two subdorsal, one on each side. On the ninth segment is a single median conical tubercle, not quite so high as those on the eighth segment, but larger at the base. The subdorsal tubercles on this segment are slightly larger than those on the eighth segment. The suranal plate is subcordate, being excavated in front; behind it is subtriangular, with two black tubercles at the end, which are smaller than those on the side in front of the middle; the suranal plate is greenish, like the prothoracic segment, while the body is tinged with yellowish, with eight faint rather broad whitish longitudinal stripes. The spiracles are black. The thoracic legs are black. The anal legs are greenish, with a blackish patch on the outside near the planta.

In this and the next stage it continues to feed on the under side of the leaf.

Stage IV (?).—(After third molt, June 29.) Length, 8 mm. The head is still black, but the two horns are now wholly black, as long as the body is thick, *and spinulated. All the other spines are solid and black;* the two dorsal spines on the eighth abdominal segment being two or three times larger than the others. *The body is now somewhat reddish above* as well as beneath, and the longitudinal stripes are reddish. The prothoracic spines are now rudimentary and button-like.

Stage V (?). — (After fourth molt, July 5, Bridgham.) Length, 10 mm. *The head is now gamboge yellow,* smooth and polished. The two horns as before, being rather slender and spinulated throughout. The body is yellowish green, with faint darker green longitudinal stripes. The tubercles are obsolete, except those on the eighth and ninth abdominal segments, which are black and moderately large.

The following notes were made on caterpillars found in Maine and represent the two last stages of the larva.

Stage V (?).—Length, 20 mm. Head cherry red, about two-thirds as wide as the body, smooth and rounded. Prothoracic tubercles arranged as in the previous stage, *but a little larger and more conspicuous;* in one example the anterior and posterior dorsal ones are coalesced. The second thoracic horns are black, not much more than half as long as the body is broad. *Now the white stripes alternate with the dark-green ones, which are quite distinct,* the black tubercles being situated partly on them. *The tubercles on the abdomen are longer and sharper than before,* and on the base in the middle of the suranal plate is a transverse black plate. The black plate on the ends of the abdominal legs are larger and more conspicuous than before.

Note.—Being now somewhat more exposed when feeding, the head has become of a bright cherry red color, and the body more striped; the armature is longer and sharper, except the two most conspicuous horns of the second thoracic segment.

Final Stage.—Length, 35 mm. The head is considerably narrower than the body, of a uniform pale clay ochre yellow. The prothoracic segment is armed with eight black tubercles arranged in a row across the front edge, the lowest one being placed just above the insertion of the legs, and being acute, while the others are more rounded and button-like. The second thoracic segment bears two dorsal slender black horns, one-half as long as the segment itself is wide, slightly tapering from the base to the end, which is rounded and somewhat truncate. The third thoracic segment with four black conical tubercles like those on the first segment.

The eighth abdominal segment is provided with three black tubercles on each side; the lowest one on this and the seventh segment being larger and sharper than the corresponding ones on segments 1–6. The ninth segment is furnished with a median sharp tubercle, apparently of double origin, as it is slightly forked at the tip; it is about two-thirds smaller than the lateral ones.

The suranal plate is triangular, with the surface flat and rough, ending in two black conical spines, with three on each side in front (in one example two are wanting on one side, and the corresponding ones on the other side are white).

The body is pale pea-green, washed with white on the back between the seven dark-green stripes, one dorsal and three on each side, which are wider and diffuse. The thoracic legs are pale flesh, the abdominal ones greenish. Anal legs large, triangular, rough and granulated, with a few black and white conical spines on the edge above the planta. The fleshy lateral ridge is well developed and washed with a reddish flesh tint on the eighth and ninth segments. The spiracles are jet-black and are conspicuous. The body beneath is as deep, if not deeper green in hue than on the upper side.

Life History of Anisota senatoria (Abbot and Smith).

The larvæ hatched August 1 and 2.

Stage I.—Length, 3.5 mm. Head large, round, smooth, wholly black, a little higher than wide; when seen from in front a little wider than the body. Prothoracic segment a little wider than the second thoracic segment, smooth, unarmed, but with a transverse dusky patch extending across it. The second thoracic segment bears a pair of high clavate spines, which are a little longer than the head is wide, and each bearing two terminal bristles of unequal length. The spines are black, being of the same color as the thoracic legs. The body is *wholly greenish yellow*, with long, rather pale, yellowish-brown hairs arising from conical tubercles. The end of the body is a little more yellowish than towards the head.

August 4 the same larvæ had become 5.5 mm. in length. The body was now *green*, with no yellow tints, and the two horns are *black*. The head is scarcely as wide as the body, and the hairs are greener and less conspicuous.

Stage II.—August 10–12. Length, 7–8 mm. *Head, prothoracic segment* above and horns, with the suranal plate and anal legs jet-black. The body is now *dark green with yellowish-green lateral lines and black conical acute warts. A median dorsal dark line; a subdorsal pale yellowish-green line, and below it a lateral wider line of the same hue, separated by a very narrow dark-green line from a broad lateral line which includes the lateral swollen ridge*, and a row of conspicuous black tubercles. Under side of body dark green. The tubercles on the eighth and ninth segments larger than those in front, suranal plate rough, tuberculated, black. Thoracic horns large, long, black, nearly twice as long as the body is wide, and one-third longer than the head is wide. Thoracic legs black; abdominal feet dark green, except the anal pair, which are black.

Stage III.—August 20. Length, 13 mm. The specific characters now appear, so that the larvæ may be easily identified. The head is slightly narrower than the body. Prothoracic plate distinct, black. The thoracic horns are black, one-third longer than the body is thick. The body is dark yellowish green, or rather olive green. *with two narrow yellowish dorsal lines*, and a subdorsal and a lateral yellowish line on each side. The spines are a little longer and sharper than before, otherwise the larva is as in Stage II.

Partial Life History of Anisota virginiensis (Drury) (pellucida A. and S.).

For the larvæ on which the following descriptions are based, I am indebted to Joseph Bridgham, Esq., who sent them from Providence, July 1.

Stage II.—Length, 7 mm. Head large and full, dark umber, wider than the middle of the body. The prothoracic segment is broad, with the front and sides flaring; upper surface dark chestnut. Body chestnut-amber. From the second thoracic segment two very long, sparsely spinulate, black horns arise, which are nearly half as long as the body; they are a little flattened at the tip, ending in two piliferous tubercles. There are on all the other segments six rows of conical acute black tubercles; the eighth segment is armed exactly as the seventh. On the ninth is a single median spine. The tenth segment or suranal plate is paler than the body, and near the edge are six whitish tubercles; and at the end are two long, piliferous tubercles. The spiracles are distinct, being ringed with black. The thoracic and middle abdominal legs are black; the anal legs of the same varnish-colored tint as the suranal plate. The skin of the body is rough, with two lateral ridges, on the upper one of which the spiracles are situated and on the lower a spine. Across each segment behind the

spine is a transverse row of small whitish warts, and other granulations are scattered over the body. The caterpillar is dark, and a somewhat conspicuous object on an oak leaf. It molted about July 14 or 15.

Stage III.—Length, 15 mm. Head light chestnut; slightly narrower than the body, which is much as before in color and appearance. The two horns on the second thoracic segment are now much shorter in proportion, being one-third longer than the segment is wide, or as long as the second and third thoracic and first abdominal segments taken together. The color of the body is the same, but the white granulations, very unequal in size, are more distinct than before. The spiracles are wholly black, and situated between two indistinct broken white parallel lines. The black dorsal spines on the third thoracic and first abdominal segments are smaller than those on the other abdominal segments; those on the eighth and ninth segments are of the same size and larger than those on the other abdominal segments. The suranal plate and anal legs are of the same color as the rest of the body. It molted July 22, having been about seven days in this stage.

Stage IV.—Length, 21 mm. Head as before, as wide as the body in the middle. Some new marks now appear; there is *a broad, dorsal, dark, longitudinal band* composed of a series of square, dark patches, sprinkled over with thickened white granulations, *and a subdorsal band* of the same color, composed of oblong, dark patches, bearing a spine above, and on the lower edge the black spiracle, situated on a white field. The skin is of the color of beeswax. There is a median black forked spine on the ninth abdominal segment. The suranal plate is as before, but the tubercles are long and slender, rounded at the tip, and porcelain white. The two spines at the end of the suranal plate are tipped with black; this plate and the anal legs being paler than the body. The horns on the second thoracic segment are now shorter than before, or as long as the third thoracic and first abdominal segments taken together. The other spines are as before, those on abdominal segments 4-8 being larger than those on the three segments in front.

For comparative descriptions of the final stage of this and of *A. stigma*, by Dr. C. V. Riley, see our *Forest and Shade Tree Insects*, 125, 127.

Partial Life History of Anisota stigma (Fabr.).

For this larva, received September 12, I am indebted to Mr. James Angus, of West Farms, N. Y.

Stage IV (?).—Length, 25 mm.; length of second thoracic horns, 10 mm. Head Indian red or dull cherry red. *Prothoracic segment with six large stout forked spines*, where those of *A. virginiensis* are small, almost rudimentary, and they are larger than in the final stage. Also the porcelain white granulations are much larger than in *A. virginiensis*. The horns on the second thoracic segment are movable and much longer than in the last stage, being nearly twice as long in proportion. The spines on all the

succeeding segments are of nearly the same size, being nearly one-half as long as the body is thick ; those on the third thoracic segment are unevenly forked and of the same size as those of the sixth and eighth abdominal segments ; those on segments 1–5 being a little smaller ; those on the third thoracic segment are more regularly bifid than the abdominal ones, which have the smaller fork lower down. The single median spine on the ninth segment is no larger than either of the two on the eighth segment, and armed with white spinules. The suranal plate is rounded with six black and several white spines, the basal black ones the largest. The skin is of a peculiar blackish pitchy color. Spiracles black. The thoracic and abdominal legs are dark pitchy ; sides of the anal legs reddish, like the suranal plate. *No subdorsal or lateral pinkish stripe, like those in A. virginiensis.*

Last Stage.—Length, 35 mm. ; of the second thoracic dorsal spines, 6.5 mm. The head is of the same color as in the previous stage. The second thoracic spine is about as long as the body is thick, and recurved ; the other spines are more curved backwards and downwards than in the previous stage, and their shape is very different, the upper surface being smooth, the spinules being collected on the under side ; the usually single large spine being white, and beyond the middle, with smaller abortive spinules on the side ; these spinules are larger on the spines of the eighth and ninth segments ; suranal plate reddish, its surface rough, with white piliferous granulations ; near the base is a large black spine on each side, and two black ones of about the same size at the end forming a fork. Spiracles black. Thoracic and abdominal legs pitchy black ; sides of the anal legs reddish. Skin dark, with more numerous white granulations than in the previous stage.

It is quite different and easily distinguished from *A. virginiensis ;* compared with this species, the head is of the same size but the color quite different, being *dull cherry or Indian red,* while that of *A. virginiensis* is yellowish amber. All the spines are much longer ; those on the back of the second thoracic longer, and those behind two or three times longer ; *that on the ninth abdominal certainly three times as long as in A. virginiensis.* The skin is blacker, and thus the granulations are more distinct, besides being larger, while *A. stigma lacks the subdorsal and lateral pink or flesh-colored bands present in A. virginiensis.** The spines on the suranal plate are stouter and longer.

Life History of Sphingicampa bicolor (Harris).

Dr. H. S. Jewett has already (*Papilio,* ii, 38 and 144) fully described the egg and the larval and pupal stages of this interesting insect, and I have only to add some details omitted by him. My descriptions were drawn up from living specimens, supplemented by examination of the

* Riley says that the body of *A. pellucida* is two-striped and that the spines are shorter than in *A. stigma.*

alcoholic specimens of the different stages. We have, perhaps, a no more interesting and beautiful caterpillar, whether we consider its peculiar appendages, its rich and gorgeous coloration, or its defensive habits, and the most carefully described details will not be superfluous in comparing the different stages with those of its allies, *Citheronia regalis* and *Eacles imperialis*, and the allied South American forms. I am indebted to my friend, Mr. W. N. Tallant, of Columbus, Ohio, for sending me a good supply of eggs from which the second or July brood of larvæ hatched. The food plant is the honey locust (*Gleditschia triacanthos*), though Dr. Jewett adds *Gymnocladus canadensis*, or Kentucky coffee-tree.

Egg.—Flattened oval, disk-like, each end alike. Length, 1.8 mm.; width, 1.5 mm. At first green in color, as the embryo grows, states Jewett, the egg becomes biconcave and changes to yellowish brown, and from thirty-six to forty-eight hours before hatching the head of the larva shows through as a dark brown spot. The egg is about one-half as large as that of *Eacles imperialis*, but of the same shape. The shell under a lens appears smooth, like parchment; under a one-half inch objective the surface is seen to be ornamented with very faint polygonal impressed areas, which are much fainter and less easy to detect than those of the egg of *E. imperialis*. The swollen nucleus or bubble in each polygon is very indistinct.

It is interesting to compare the sculpturing of the shell with that of *E. imperialis* and *Citheronia regalis*, the former being intermediate between Sphingicampa and Citheronia. In *E. imperialis* the shell is sculptured a little more distinctly with irregular polygonal imprints which are not so closely crowded as in Citheronia, and the median raised nucleus or bubble is pale but tolerably distinct. Length, 3 mm.; width, 2.5 mm. In the shell of the egg of *C. regalis* the polygonal impressed cells are easily recognized under the microscope and faintly detected under a strong lens. The cell imprints are much more distinct and more crowded than in the two other genera, while the median nucleus or bubble is more prominent and darker; it varies in diameter in different cells, being from about a third to a half as wide as the cell itself. The walls are quite irregular and not always distinct.

Larva Stage I.—(Described four to five hours after hatching.) Length, 4 mm. The head is large, rounded, smooth, unarmed, except with a few scattered tapering dark hairs; it is blackish chestnut; it is wider than the body and slightly wider than the prothoracic segment, which is broad and flaring in front, as in Anisota. It is rather higher than wide, and on the vertex slightly bilobed and is paler in front than behind. The terminal joint of the antenna is slightly bulbous and bears besides the tactile bristle about three olfactory rods.

The body is subcylindrical, a little flattened, but not so much so as in Anisota. The prothoracic segment is broad and flattened, smooth and unarmed, except with about a dozen dark small hairs. On each side of the second and third thoracic segments is a subdorsal pair of remarka-

ble movable spines, nearly two thirds as long as the body, which open and close together like great arms, spreading apart, or directed forwards and outwards more or less constantly while walking, the creature at this age being rather active; they are evidently at this period defensive organs. They are stout, thick at the base, those of each pair close together at their base; they slowly taper towards the end, and are armed with 12–14 short, thick, blunt, dark spines; at the end of the spine is a remarkable bulbous expansion somewhat chestnut-shaped, being a little flattened and subtriangular, broad at the end, from each side of which arises a small slender tubercle bearing a blunt, stout spine about a third longer than the tubercle. The appendages themselves are dark chestnut, pale amber at base and on the outer third, but the bulbous tip is dark reddish black. Those of the third thoracic segment are very slightly shorter than the pair in front and in each pair the outer spine is the shorter. These horn-like appendages are flexible, especially near the end, and are sometimes bent over and around so as to form a decided bow or curve, or even a nearly complete circle. Compared with those of *Citheronia regalis*, which they most nearly resemble, those of *Eacles imperialis* being forked at the end, the bulbous tips are a little longer, but still of the same general shape and size.

Along the abdominal segments are six rows of very long and slender conical tubercles, giving rise each to a single black seta, which is about a third longer than the tubercle; there are thus six piliferous tubercles on each segment (1–7), the lowest of which, one on each side, is situated just above the base of the legs, and has a double base, sending off posteriorly at nearly right angles to the main tubercle a small lateral one, which emits a black bristle.

On the eighth segment is a very large, stout, acute, bright-red horn, which is borne either erect or directed a little forward; it ends in two long, slender tubercles, each bearing a bristle about as long as the tubercle, and along the trunk are several large spinose tubercles, each ending in a black bristle. The dorsal median tubercle on the ninth segment is broader than long, being transverse, and bears two bristles. The suranal plate is rather narrow, much narrower than long, and ending in two long slender tubercles, each bearing a dark bristle, besides four other bristles. The anal legs are provided with a dark patch on the side and bear long bristles, while there are three black bristles on the base of each middle abdominal leg. There are sixteen (possibly eighteen) crochets on each of the abdominal legs. The body in general is pale green, with a slight yellowish tinge.

There is a median linear dorsal line along the body, and on each side are four narrow dark lines on a green ground, the two middle lines being diffuse, and enclosing a dark band and bearing a row of bristles. The freshly hatched larva spins a silk thread, which after a while is annoying to the observer from its being in the way and adhering to the leaves of its food plants.

The larva, July 17, just before moulting.—Length, 7 mm. The head is now small, black, one-half as wide as the body, which is filled out from five days' feeding. The longest thoracic spines are scarcely one-third as long as the body, and all are pale reddish amber at base and on the outer third, the terminal knobs being black-brown. The caudal horn is also pale reddish amber at base. There is now a definite, broad, white, lateral stripe along the abdominal segments (not appearing in the thoracic), which is bordered above by a dark, thread-like, brownish, spiracular line, enclosing the spiracles which are minute and difficult to detect. Above the spiracular line is a linear distinct white line, and above this is the pale-green subdorsal stripe, diffusely edged on each side with a darker tint. There is a median, small, rounded, amber-colored, dorsal tubercle on the ninth segment, which is double, bearing two bristles. The end of the suranal plate is reddish amber, bifurcate and bearing black bristles. There is a dark patch on the outside of the anal legs.

Stage II.—Moulted July 18 and 19. Length, 10 mm. The head is now high, *slightly angular on the sides;* black-brown with *a light-brown or greenish lateral stripe* on each side, diverging from the light-green vertex to the antennæ, the two stripes varying from pale brown to green. The great spines (both thoracic and caudal) are of about the same proportions and colors as in Stage I, except that the eight thoracic spines, which are still no shorter in proportion to the body, are not so much swollen at the end, the bulb being shorter and broader, and the spines larger, making a more decided fork, and thus resembling those of *Eacles imperialis.* On each of the abdominal segments there is a posterior, transverse row of *six dorsal, distinct, piliferous, conical warts,* there being only two minute ones in Stage I. The anterior series of piliferous tubercles on each segment are now rather large, conical, *the two dorsal ones large and stout,* twice as large as the subdorsal and lateral ones, and all being lemon-yellow (less greenish than before) bearing a terminal black spine, and with a second pilliferous tubercle growing out from the side.

The dorsal lines have almost disappeared, there being a subdorsal, pale, almost whitish line, besides a faint, narrow, dorsal, greenish line. *The lateral ridge is now prominent, and bright lemon-yellow,* forming a distinct broken line, bearing in the middle of each segment a very slender, blackish, piliferous wart. A dark reddish purple, narrow, spiracular line; between this and the yellow line is a white stripe and another narrower one above it, while still above is another reddish purple line. Otherwise the markings are the same, the suranal plate, however, is edged with lemon yellow, being the continuation of the lateral yellow band.

Thoracic and abdominal legs "green tipped with brown" (Jewett).

In this stage upon touching or teasing the larva the thoracic spines spring out, at the same time the head together with the thoracic region jerk violently, as if to beat off an intruder. Also when two caterpillars meet they evidently attack each other, butting and striking with their horns, like two hostile goats, deer or cattle. It seemed evident, after

repeated observations, that the great thoracic spines are of real defensive use.

An examination of Fig. 2 will illustrate better than a prolix verbal description the appearance of the spines in Stages I and II of this species. They are all drawn with the camera, and it is to be observed that the "horns" are more like those of *Citheronia regalis* than *Eacles imperialis*. *a*, one of the horns on the second thoracic segment; *a'*, the extremity enlarged, showing the circular corrugations; *a''*, the same more magnified; *a'''*, a terminal spine enlarged, showing its mode of insertion; it contains a central mass of minute globules; *b*, the first abdominal segment enlarged to show the position of the dorsal, subdorsal, supra-spiracular and spiracular stripes, the latter enclosing the spiracle; also the position of the four spines, one dorsal, one subdorsal and two infraspiracular; the spines are all minutely barbed; *c*, a dorsal spine, bearing a spinule at its base; *d*, "caudal horn" or medio-dorsal spine on eighth abdominal segment; ix, that on the ninth segment; it is small, conical and forked at the end, each fork bearing a long seta. All the foregoing in Stage I. *f*, a "horn" from the second thoracic segment, Stage II; the two terminal spines have entirely changed in shape, being larger and longer, and bearing a tapering fine bristle; a third smaller conical tubercle has appeared near the base of one of the forks. The spinules on the trunk now bear a bristle; *e*, "caudal horn" of Stage II; now large and high, deeply forked at the end; the spines or tubercles on the trunk or the horn now bear each a slender bristle.

Stage III.—Molted July 26, 27. Length, 13–15 mm. The head is now high, the face subtriangular, not black as before, with a green lateral stripe, but *pea-green with a yellow stripe on each side*, shaded more or less with black between the yellow V; and on the outside, in one example, the black is reduced to a diffuse patch inside, while in another larva it is outside of the yellow V. The head is now nearly as wide as the body.

The eight horns are still nearly half as long as the whole body and are now paler than before, being reddish chestnut and yellow at base, with black spinules and blackish at the tips, which are now not bulbous, only irregularly forked. The spines along the body are larger and stouter than before; the tubercles at base are deeper yellow than before, tipped with black, while the high, conical or (sometimes) rounded granulations are snow-white. The lateral yellow stripe along the body is more distinct than before; it is bordered above with pure white, and above this is the linear dark purple spiracular line, shaded above more distinctly than in the preceding stage with deep blue-green or verdigris green; the caudal horn as before being pink, with white spines bearing black bristles. The larva also differs from that of Stage II in the suranal plate, which is more deeply forked, *the forks being thicker, larger and with several tubercles;* the sides of the plate are heavily spined and on the surface are about six central, small, conical spines. Now the dorsal abdominal

spines are *distinctly ivory-white on the outer side from the base up to the dark tip.* The spiracles are much larger than before, distinctly interrupting the dark purple spiracular line which is paler than before.

Stage IV.—Molt not seen, but it probably occurred August 1 or 2. Length, 25–28 mm. The head is, as before, with two yellow stripes, one on each side, and bordered more or less on each side, especially in front, with black. *The four pairs of thoracic horns are now but little longer than the body is thick* and are reddish flesh-color, dark at the slender forked tips, and yellowish green at the base.* *The "caudal horn" is now considerably shorter in proportion than before, being about two-thirds as long as the body is thick,* and is of the same peculiar deep flesh-red as the thoracic horns. The sharp, stout, spine-like tubercles on the fourth and sixth abdominal segments are slightly over twice as large and thick as the other dorsal tubercles which are as in the previous stage, and bear a verticil of from three to five short blunt spinules; *they are now silvery white on the outside* (Jewett says burnished silver). The lateral yellow, carmine, white and blue bands are much as before. The increase in size of this stage over the preceding one is noticeable.

In his account of this stage Jewett states that the head is "green, bilobed, minutely pubescent," also that the thoracic horns had lost their knobs at their extremities; but this appears to take place at the time of the second molt.

In a larva 20 mm. long, and probably of this stage, the lateral band is tricolored, marked below with straw-yellow, the yellow enclosing the base of the black spines. Jewett says: "The legs of some larvæ are green and of others brown. Prolegs of some green and in others green tipped with brown. In some larvæ the stigmatal space has numerous small, black tubercles on each segment; in others there are no black tubercles."

The following description of another larva, drawn up October 10, and probably in the fourth stage, may be useful.

Stage IV (?)—Length, 24 mm. Body rather thick. Head remarkably Sphinx or Smerinthus-like, as wide as the body, flattened in front, broad below about the mouth, but narrowing towards the vertex, as in Sphinx; the skin rough; with two lateral, rather broad, yellow lines, which arise from the base of the antennæ and converging nearly meet on the vertex; across the upper division of the clypeus is a blackish band which adjoins a black blotch on each side, and which touches the yellow line. Labrum pale yellowish, blackish in the middle; eye-patch and mandibles black.

Prothoracic segments very slightly wider than the rest of the body in front; the front edge flaring and rising up somewhat collar-like; this edge armed with a single row of white tubercles, about ten on each side of the segment, those above nearly adjoining at base and tinged with

* Jewett says the spines are "brown in some larvæ and green in others."

yellow ; those on the sides below pure snow-white ; behind the front edge are four small but distinct white warts, two in the middle.

The second and third thoracic segments each with two widely separated pairs of horns, not quite so thick as the caudal horn, each about two-thirds as long as the segments bearing them are wide ; they are slightly recurved and scattered over them are conical white tubercles which are irregular and blunt at the end ; they are yellowish at base, near the middle becoming dark pink and at tip reddish black-brown. On the front edge of the second thoracic segment between the horns is a row of three conical sharp tubercles, with a similar and some minute ones on each side, while on the third segment are two similar white warts.

Across the dorsal side of the abdominal segments 1–7 are two rows of white, sharp, conical tubercles ; two of those on the front edge of each segment being longer and sharper than the others and directed backwards. On these same segments (1–7) is a third set of curious tubercles, mostly large conical and black internally, but on the outside shining opalescent pearl or silvery white, and resplendent, glittering brightly by lamplight. Of these curious spines those on the first abdominal segment are smallest, and those on segments 4–6 are largest, being about one-third as long as the caudal horn ; the pair on segment 6 being the largest. The "caudal horn" on the eighth segment is large, with a few white tubercles, those at the end of the horn being reddish ; the tip is slightly forked, there being two minute tubercles ; all those on the sides of the horn bear a short fine hair. In the middle of the ninth abdominal segment and in a position homologous with the caudal horn, is a minute, short, median, white wart, which is reddish at the base. The suranal plate and hind legs are very large, the surface rough and heavily warted, especially on the edges ; the lower edge of the anal legs and suranal plate are interrupted with black. The eighth and ninth segments and base of the suranal plate are a little wider than the middle abdominal segments. The suranal plate is a little longer than wide, subacutely triangular, the tip forked and ending in two rather large tubercles, which are greenish at the end, blackish at base, with a little transverse median black stripe in front.

The stigmata are deep flesh-colored, with a slit in the middle, whitish, especially at the end. The stigmatal line along the side of abdominal segments 1–8 is whitish, edged above with purple, and still above washed irregularly with livid greenish blue, while from the eighth segment to the tip of the suranal plate the line is straw-yellow. Below, near the base of the feet, is a lateral row of sharp black spines ; there are several on the sides of the thoracic segments and one rather large one under each spiracle, with smaller sharp ones below. The thoracic legs are black ; the middle abdominal legs large, greenish, with two or three alternating rows of sharp black spines near the base, and also with fine white tubercles like those on the rest of the body. Along the middle of the under side of the body the skin is immaculate green.

Stage V and last.—Length, 35–38 mm. (Jewett says from two to two and a half inches when fully grown). The head is now not angular but rounded, though slightly narrowing and produced above; dark pea-green, considerably darker than the body; with a broad yellow band beginning on the antennæ and fading out on the vertex. The ocelli are black; the mandibles black; the anterior lobes of the labrum brown, including the palpi. The head is about two-thirds as wide as the body, the surface covered with fine minute granulations arranged in groups (only seen under a strong Tolles lens).

The body is thick; the prothoracic segment short, and not so wide as the second thoracic segment. It is unarmed, its front edge with a transverse series of white bead-like warts set close together. Behind, the body is thick, being of the same thickness as far as the eighth abdominal segment. Second and third thoracic segments each with two pairs of very large spines which are about two-thirds as long as the body is thick; the outer one of each pair is slightly shorter and slenderer than the inner, but those of both pairs are alike in size; they are roseate, pale coral-red and not so near in tint to the spines of the food-plant as in the young; when the caterpillar is at rest they are held close together in a recurved position and in the grown-up larva when touched they are not moved or the body jerked in response to such stimulus. They are adorned with white blunt spines, which are often tipped with black.

"The 'silver horns' on the fifth to the tenth segments are now one-sixteenth to one-eighth of an inch long, bright pink inside and burnished silver externally. The number of these 'silver horns' varies in different larvæ, some having them only on the seventh and ninth segments; others have them on the fifth, seventh and ninth segments; still others have them on the fifth, seventh, ninth and tenth segments" (*Papilio*, ii, 49). "I have now to add that this year I reared three larvæ having these silver horns on every segment except the twelfth; still the imagines from these three larvæ did not differ from the ordinary form" (Jewett, *Papilio*, ii, 144).

The horn on the eighth abdominal segment is now only about one-fourth shorter and thicker than the thoracic spines, and is of the same color and structure, the spinules being conical, rounded, blunt, white, and bearing a fine bristle.

On abdominal segments 1–7 are two dorsal rows of acutely conical spines, which are recurved and directed backwards. Those on the fourth and sixth segments are twice or thrice as large as those on the other segments (1–3 and 4 and 7) and provided with three or four blunt spinules; the spines themselves are roseate on the inner side, and externally brilliantly painted with a pearly silvery white, giving off all the colors of the rainbow during the movements of the animal. The corresponding spines on the other segments are painted in the same fashion though less brilliantly.

On the side of the body from the third thoracic horns to the eighth ab-

dominal spiracle is a bicolored stripe; it is pure marble-white below, and above rosy purple, and is interrupted by the wax-colored spiracles, which extend above the upper limits of the reddish line. The suranal plate is very large and long, deeply divided at the end, the two forks being, like the surface, coarsely granulated with stout short conical spines; the plate is green, with the edge straw-yellow. There is a minute median spine on the ninth abdominal segment. Each abdominal segment with two dorsal transverse rows of white, bead-like, coarse granulations. Below the bicolored lateral stripe is a black, double, conical spine on each segment, and underneath on abdominal segments 1, 2, 7 and 8 is a group of unequal, smaller, black, sharp spines. The body beneath is granulated with white, and also on the sides, as well as above.

The thoracic legs are black, partly greenish beneath; the abdominal legs, including the anal pair, are greenish, with a group of singular black piliferous spines, while some of the spines are tipped with white.

The general color of the body is of nearly the same hue as the under side of the leaves of the honey-locust, and thus colored it is partly assimilated and protected by its color, while the horns are in general like the spines of its food plants. On the other hand the gleaming silvery spines certainly render the creature conspicuous, as well as the lateral parti-colored band.

It would appear probable that the formidable spines of the grown-up caterpillar save it not infrequently from being swallowed by birds; though the horns are probably of greater use in the earlier stages when they are much longer and much more movable, in frightening away ichneumons and Tachinæ. For example, even when 20 mm. in length, a larva was seen when teased to spread apart its great arm-like horns, while the full-fed ones did not notice such stimulus.

Summary of the salient Features in the Ontogeny of Sphingicampa bicolor.

A. Congenital Characters of the Larva; all appearing in Stage I.

1. The two pairs of enormous spines of second and third thoracic segments one-half as long as the body, and ending in a two-spined, large, flattened, dark bulb; freely movable and plainly defensive in function.

2. The large, reddish, spiny "caudal horn," on the eighth uromere, ending in two bristles.

3. The double piliferous tubercle on the ninth uromere; becoming obsolete in Stages IV and V.

4. The abdominal region is longitudinally striped with dark and whitish bands, but there are no transverse marks in Stage I or in later stages.

B. Evolution of Later Adaptational Characters.

1. The head slightly angular, face subtriangular, with a light brown or greenish lateral stripe (Stages II–V).

2. Appearance of a transverse row of dorsal granulations on the hinder end of each segment in Stage II, persisting through larval life.

3. The eight thoracic spines lose their bulbous tips, and become simply slightly forked in Stage III, and later.

4. The two dorsal spines of uromeres 1–7 are in Stage II larger than the others; in Stage III they become ivory-white externally, and in Stage IV larger and silvery white on the outside.

5. In the last two stages the eight thoracic spines become very much shorter in proportion to the size of the body and become less movable; as they decline in size and functional importance, the metallic, silvery, dorsal spines on the abdominal segments become conspicuous and apparently useful to the larva.

One larva, 36–37 mm. in length, ceased feeding August 7, and began to pupate, but I did not carry any into the pupa stage.

What Dr. Jewett means by saying that "the larvæ change only in size during the last moult," we do not understand, as the increase, so far as we have noticed, is gradual from Stage I to V, as in other larvæ. The brood which Dr. Jewett raised in Ohio, "began to quit feeding on the 20th of June, entering the ground within a few hours after ceasing to eat. Then they pupated within an oval cell lined with a thin cocoon of silk, the first casting its skin on the 24th. The pupa is at first bright green, but changes to jet black in a few hours."

"Imagines began to appear on July 3, and had nearly all emerged by July 10. The insect is three-brooded here, hibernating in pupa. Although the large majority of each brood follows the cycle of development as described, yet a few of each brood are much slower in making their changes. Thus a few of the brood did not complete their growth till the end of July, and three pupæ, formed June 26, are still alive (February 28), having hibernated. Other pupæ of the same brood disclosed their imagines at various periods during July and August. This accounts for the fact that larvæ in all stages of development may be found at any time throughout the summer till frost kills their food-plants" (Jewett).

Remarks on Sphingicampa bicoler.—This is the most Sphinx-like of any Ceratocampid or other Bombycid I know, resembling sphingid caterpillars in the following characters:

1. The shape of the head and its markings.

2. The four thoracic horns (like those of Ceratomia) perhaps a case of reversion in the latter.

3. The caudal horn.

4. The large, square, heavy anal legs.

5. The skin granulated with small white tubercles.

One can, when we take into account the larvæ alone, well imagine that the Sphinges are, as claimed by Mr. E. B. Poulton, descended from the Ceratocampidæ, though these may be only adaptative characters, and not applicable to the imagines, which differ in venation, in the tongue, and in the proportions of the head pieces.

The horns in Sphingicampa are not held spread out as in *C. regalis*, but those of each pair are constantly held close to each other. The horns and the six silvery, opalescent, shining tubercles probably become terrifying by the movements of the larva. The latter are turned on and throw their light out suddenly like flashes and may thus have a deterrent effect on their enemies.

Life History of Eacles imperialis (Drury).

The eggs were received from Mr. James Angus, and the larvæ hatched from them reared in Maine, so that their development, owing to the cooler climate, may have been less rapid than in New York, where the eggs were laid.

Egg.—Length, 3 mm.; breadth, 2.5 mm.; thickness, 2 mm. Flattened elliptical, each end alike, white, with an equatorial, smooth, distinct ridge. The shell is white, the surface under a high-power triplet is seen to be finely pitted, the pits being shallow and not closely crowded. Under a half-inch objective the pits are seen to be shallow, and not often with a definite raised edge; often there is a boss or bead in the centre. Arising from the spaces between the bosses are slender, short, very minute hairs, originating from a swollen base. Under a one-fifth objective, as well as a one-half and a triplet, I cannot distinguish between the microscopic structure and markings of *imperialis* and *regalis*.

The Freshly Hatched Larvæ.—Some were seen drawing themselves out of the shell June 30, at noon. Length in a few minutes after hatching 7–8 mm.; width of head, 1.5 mm. The tubercles and spines become erect before the larva entirely deserts the shell.

The head is large and full, smooth, shining, nearly twice as wide as the body behind the middle, but the prothoracic segment is much wider than the body; the prothoracic segment is above of the same color and the surface shines like the head. The body is pale chestnut, with a slight pinkish tint. All the spines are, before it entirely leaves the egg, shining jet-black; the five longest ones (four thoracic and one median abdominal) bearing white hairs, the end hairs on all the shorter ones being black. The thoracic segments are without transverse dark stripes, but on each of abdominal segments 1–7 there are three transverse, distinct, conspicuous, black dorsal stripes; the first one in front of the spines is broken, and wanting on the first abdominal segment; but the two behind are unbroken and extend a little below the position of the spiracles. The spiracles are hard to detect as they are situated on an oblong or fourth transverse black band between the two lateral spiracles. The eighth and two last segments are not banded. The large anal legs are edged with black behind. The thoracic legs are black.

There are four spines on each side of the prothoracic segment, all of very unequal length; the lowest one minute and bifid; the one in front of the spiracle stumpy and ending in five slender, papilliform, piliferous

tubercles. The subdorsal one is much longer and forked, while the two dorsal ones are very long and slender, about as long as the head is broad and deeply forked, each fork bearing a bristle. *The two dorsal tubercles on the second and third thoracic segments are enormously long and very slender*, being about half as long as the body. They are deeply forked, each fork long and slender, and bearing a long bristle. The tubercles on abdominal segments 1–7 are small and short, of nearly equal length, simple except those of the infraspiracular row, which are deeply forked. The single median tubercle on the eighth abdominal segment is remarkably long and slender, about two-thirds as long as the thoracic ones. *There is also a single median forked tubercle on the ninth segment*, not half as long, however, as the one directly in front. *The suranal plate bears at the end two long five-branched piliferous tubercles.* All the tubercles are of nearly the same color as the body, the five longest ones, however, a little brownish near and at the end.

The four middle pairs of abdominal legs are shining black externally on the outer half; otherwise they are concolorous with the body.

The following description is drawn up from some larvæ at the end of Stage I, living October 9 or 10 and reared by Mr. Bridgham: they were about 7 mm. in length and had been kept for a number of days and died before molting. The head is large, full and rounded, smooth and shining honey-yellow; nearly twice as wide as the body (actual width, 1.5 mm.), rounded above on the apex; the eyes and mouth-parts black; labrum whitish. The body is ochreous. The prothoracic segment is very broad and flaring in front, nearly as wide as the head, bearing ten black spines, of which the two dorsal ones are about as long as the body is thick, each bearing three or four small, short tubercles, and ending in a long fork, each branch bearing a long seta which is white at the base. The subdorsal spines are a little less than half as long and large as the dorsal ones. The dorsal second and third thoracic horns are very long and large, being nearly twice as long as the middle of the body is thick; the stalks are knotted (not tuberculated), and deeply forked at the end; each fork thick and ending in a seta. Those on the third segment are slightly shorter with a smaller fork than the two on the second thoracic segment. Each abdominal segment is provided with six black spines; the two dorsal ones about half as long as the body is thick, with two or three minute warts; they are forked at the end, the lower fork small, about as long as the spine is thick, and not bearing a seta, while the other fork or tine is directed obliquely upward.

The spines of the next row outside (subdorsal) are small and simple, while the lateral row near the base of the legs is composed of branched spines nearly as large as the dorsal ones, and with each branch ending in a long seta. The caudal spine on the eighth abdominal segment is nearly as large as those on the second and third thoracic segments, but with a smaller fork, each ending in a seta. There is a median dorsal spine on the ninth segment, about one-half as long and large as that on the eighth,

with three branches, the two terminal forming an uneven fork. There is no distinct suranal plate, only a subtriangular flattened area bearing along the edge six black spines of very unequal size. Around abdominal segments 1–7 is a double, black band, and the lateral and subdorsal spines on these segments are connected by a black band, also enclosing the spiracles; these short bands alternating with long bands passing over the body. The thoracic legs are black; the abdominal legs dull ochreous, with a large, black patch covering the outside. The anal legs are rather large and square, ochreous, the hinder edge pitchy red.

It may be observed that the median dorsal spines on the eighth and ninth abdominal segments are forked like those of *H. io;* this and *H. maia* being apparently earlier forms.

Stage II.—July 10, 11. Length, 13–15 mm. The head is as wide as the thoracic segments (exact width, 2 mm.); it is chestnut brown, a little darker on the sides above the eyes and on the clypeal region. The spines on the prothoracic segment are much as before, *but stouter and shorter.* The dorsal spines on the second and third thoracic segments are much as before *but not quite so deeply forked;* they are dusky amber wax at the base, and black beyond; they are irregularly spinose from base to tip; each fork bears a white hair. *All the other spines are black.* The "caudal horn" on eighth abdominal segment is stouter at base, the trunk with larger, longer and more numerous spinules, which end in a bristle which is not present in Stage I; it is still evenly forked.

The subdorsal spines are now much shorter than before and simple and conical; while the lateral series, instead of being nearly as long as the dorsal ones and deeply forked, are short and stout, ending in three short, stout, piliferous spines.

The body is now dull chestnut, with dusky discolorations, but *without the decided black bands and spots of Stage I,* the body being decidedly darker. The black spiracles are surrounded by a diffuse black ring. The thoracic legs are black; the middle abdominal legs jet-black outside, on a chitinized portion; the anal legs are of the color of beeswax, with a jet-black spot or wart at the tip, and a dusky patch on the sides; these black plates are *larger and longer than in Stage I.*

The descriptions of Stages III and IV were drawn up from a series reared at my request by the late Mr. S. Lowell Elliott and preserved in alcohol; the colors are described from a set of drawings by Mr. Bridgham. Mr. Elliott observed five stages.

Stage III.—(Preserved the third day after the second molt.) Length, 30 mm.; width of the head, 3 mm. The head is narrow, about one-half as wide as the second and third thoracic segments; chestnut brown with two pale, longitudinal bands in front, each band ending at the base of the pale antennæ. *The two dorsal spines on the prothoracic segment are much shorter* than in Stage II, with much stouter lateral spinules, and with shorter forks at the tip, and the spines on the trunk are shorter. The two second thoracic dorsal spines are a little stouter than before, but are

nearly as in Stage II, and are spinulated in the same way; they are 4.5 mm. in length; they are pale on the basal half and dark brown on the distal half; the corresponding spines on the third thoracic segment are a little shorter. *The dorsal and lateral spines on abdominal segments 1–7 are much smaller* in proportion than in Stage II, the dorsal spine being still unevenly forked. The "caudal horn" on the eighth segment is now 3 mm. in length, and is still regularly forked as before. *The corresponding single median spine on the ninth segment is minute and much smaller than before.* The two larger spines on the suranal plate *are smaller than before*, each bearing four spines, and behind these on the edge of the plate are four minute conical spines; the plate is regularly rounded behind; it is dark brown in the middle, with paler rounded granulations. On the side of the anal legs is a similarly ornamented *distinct, narrow, triangular field not developed in Stage II.* The middle abdominal legs are tipped with black as before. The body is more hairy than before.

The general hue of the body is at first pale yellowish brown (raw sienna), with a large pale area around the dark spiracles. There are no distinct markings. Towards the end of the stage the body in those feeding on white pine becomes decidedly reddish, and in fact the color varies from violet through all shades of golden brown and orange purple to black. The horns are rosy-red at base; there is a broad, pale, diffuse, subdorsal band on each side and the dark spiracles are rendered very conspicuous by the broad yellowish ring around them.

Fig. 3.—Armature of *Eacles imperialis.* Stage I. *a*, a dorsal prothoracic spine; *b*, a subdorsal prothoracic spine; *c*, a dorsal spine of the second thoracic segment; *d*, a dorsal spine of the third thoracic segment; *e*, the first abdominal segment, side view, showing the anterior and posterior black band, and the position of the dorsal, subdorsal and infraspiracular spines with the spiracle; *f*, the suranal plate, in part, bearing the anterior spine, ending in four setiferous tubercles and the two smaller, simple spines at the end of one side of the plate; *g*, the "caudal horn" or medio-dorsal forked spine of the eighth uromere, seen partly from the side; *g'*, end of the same, seen from in front, showing the two forks; *h*, one of the dorsal spines on the ninth uromere; all drawn with the camera to the same scale.

Fig. 4.—Armature of *Eacles imperialis.* Stage II. *a*, end of one of the dorsal prothoracic "horns;" *b*, one of the dorsal second thoracic "horns;" *c*, the "caudal horn," or medio-dorsal spine on the eighth uromere. Stage III. *d*, one of the second thoracic "horns;" *e*, the "caudal horn" or medio-dorsal spine of the eighth uromere. All drawn with the camera to the same scale.

Stage IV.—(Four days after the third molt.) Length, 40 mm.; width of the head, 4.5 mm. The characters of the full-grown larva are now nearly assumed. The head is, in one specimen, twice banded with pale yellowish in front, in another the bands are nearly obsolete and the head almost entirely dark chestnut. The two dorsal prothoracic tubercles are now

very short, not so high as broad, and end in a group of rounded conical spinules; those on the side of the same segment having the same general shape. *The second and third thoracic segments, with the dorsal horns, now much as in the full-grown larva,* though a little slenderer; length, 5 mm.; they are more curved than before and directed backwards and provided with numerous dense conical tubercles; they are pale yellowish at base, and rosy on the distal half, becoming black at the tip, which is still regularly forked; the two pairs are of the same shape and length. The abdominal dorsal spines are much stouter and shorter in proportion than in Stage III. The subdorsal (supraspiracular) spines are simple, conical; the lateral (infraspiracular) spines are very short, and composed of four spines. *The "caudal spine"* (single median dorsal spines on eighth abdominal segment) *is now much stouter, more conical than before;* 2.5 mm. in length and furnished with crowded spines, but still ending in a regular fork. The suranal plate is as before, but the spines are shorter, and the exterior of the anal legs are ornamented as before.

The hairs are now long and abundant, some of the dorsal ones longer than the body is thick. The spiracles are very conspicuous, each being surrounded by a broad green ring, outside of which is a yellowish ring, which is margined with yellowish brown. The body is dark umber-brown; the reddish spines and the spiracles, as well as the reddish edges of the suranal plate and anal legs, decidedly contrasting with the dark hue of the body. The color of the spiracles varies in different individuals, being sometimes mostly white or green or red. Also the yellow color around it is sometimes large and of different width, sometimes being reduced to a line.

The last stage differs from Stage IV in the shorter dorsal horns and caudal horns, those on the sides also being decidedly shorter, and the anal legs are larger, with a wider dark granulated area on the sides, and the body is much thicker and heavier, while the head is pale.

Last (Fifth) Stage.—Length, 10 cent. (Described from one living on the choke cherry.) Head one-half as wide as the body; width, 7 mm.; deep gamboge-yellow, and green on the side; a double deep black frontal line extending from the vertex, diverging below so as to leave a median yellowish line on the upper division of the clypeus. The front division of the clypeus (clypeus anterior), the antennæ, and the base of the jaws yellowish. The thoracic legs and the horns on the second and third thoracic segments and the anal legs with the suranal plate are all of the same color, *i. e.*, deep shining gamboge-yellow. The general color of the body in the green individuals is a delicate pea-green (more usually the individuals are brown or tawny), varying from the shade of the upper side of the cherry leaf to that of the under side, being paler above along the back and especially on the sutures than on the sides. The hairs are long and slender and whitish, most of the dorsal ones as long as the body is thick. There is a prothoracic plate of the same green hue as the body, but with yellowish edges. Of the four horns on the second thoracic seg-

ment, the outer ones are half as long as the inner or dorsal ones, which are 4.5 mm. in length; those of the third thoracic segment are of the same size as those on the second. There are four similar but much smaller dorsal and subdorsal horns on each of the abdominal segments (but they are shorter and more regularly conical than in Stage IV), those on each segment being of the same size, the two dorsal ones being almost three times as large as the subdorsal ones, each dorsal one bearing three terminal spines. Those on the thoracic segments are tuberculated, ending in a fork. On the eighth abdominal segment is a median dorsal horn, now shorter in proportion than in Stage IV, small and short, length 2 mm., nearly twice as large as the other dorsal ones in front, tuberculated and slightly forked at the end, but not so regularly forked as in Stage II. There is a minute median one on the ninth segment, and two minute lateral ones on each side of the segment. The spiracles are very large and conspicuous, yellow with an outer ring of very dark green, which is edged on each side with paler green; those on the prothoracic segment are without the deep-green outer ring. The suranal plate is regularly triangular, gamboge-yellow, with a swollen, rough, coarsely granulated edge, within which the surface is black, with yellow coarse granulations. A similar narrow triangular plate on the anal legs. The middle abdominal legs dark pea-green, with a deep ochre-yellow transverse band above the black planta.

For a careful description of the egg and the larva in its first four stages see Dr. J. A. Lintner's *Ent. Contr.*, ii, 150. His larvæ molted four times, and he thought from the small size of the specimens after the fourth molt, that there might be a fifth one.

The fifth and last stage differs from Stage IV in the shorter dorsal horns and "caudal" horn; the tubercles on the sides of the body also being decidedly shorter, while the anal legs are larger, with a wider, dark, granulated area on the outside. The body is also thicker and heavier, while the head is paler.

It is noticeable that in this form, as in the Attacinæ, there is a great increase from one stage to another in the size or bulk of the body, while the head does not increase in a corresponding ratio.

SUMMARY OF THE CHIEF ONTOGENETIC FEATURES.

A. *Congenital Characters.*

1. In Stage I there are three pairs of very long dorsal deeply forked thoracic horns, nearly half as long as the body.
2. A similar median spine on the eighth abdominal segment, with one half as long on the ninth.
3. The abdominal segments are transversely banded with black.
4. The lateral spines on the abdominal segments bifid and nearly as large as the subsimple dorsal ones.
5. Body pale chestnut brown; head light reddish.

6. The spiracles minute and difficult to detect, as they are situated in one of the transverse black bands.

B. *Evolution of Later Adaptational Characters.*

1. The forks of the larger dorsal spines disappear at the end of Stage III.
2. The dorsal thoracic spines become recurved in Stage III.
3. The dorsal thoracic and caudal horn become much shorter and stouter in Stage IV, when the characters of Stage V (and last) are nearly assumed.
4. In Stage II the dorsal spines on the prothoracic segment begin to grow shorter and stouter.
5. In Stage II the large horns begin to be less deeply forked.
6. The transverse black stripes disappear at the end of Stage II.
7. The dorsal and lateral spines on abdominal segments 1–7 are much smaller in proportion in Stage III than in Stage II.
8. Towards the end of Stage III the colors of the body become more conspicuous and variable.
9. In Stage III the spiracles become particolored and very conspicuous.
10. The dorsal thoracic and the "caudal horn" become much shorter in Stage IV, and not forked at the tip.
11. The hairs become long and abundant in Stage IV.
12. The body in Stage IV becomes much stouter and heavier than before, while the head has not greatly gained in size proportionately.

Life History of Citheronia regalis (Fabr.).

For the eggs I am indebted to Miss Morton, who sent them June 25 from New Windsor, N. Y. They hatched July 11. The eggs being indistinguishable in size, shape and color from those of *E. imperialis*, the reader is referred for a description to those of the latter insect. The egg-shell is so transparent that just before the larva hatches it can be seen lying curved up on its side. The head is large and black, while the body is pale, with distinct yellow sutures. Also the black thoracic legs are visible, and the black spots, those on the thoracic segments, elongated; also the dark spines and certain large ochreous patches on the thoracic segments.

Larva, Stage I.—Length, 6 mm. The head is large, wider than the body, smooth and shining black all over, with a few fine dark hairs. The body is cylindrical, black all over, with no stripes or spots of a lighter hue. A pair of large, long dorsal horns on the first thoracic segment, ending in a peculiar bulbous swelling, and on each side of the segment is a smaller subdorsal spine one-third as long as the dorsal ones, which is simple at the end, tapering to a point, bearing a short tine near the middle, and ending in a stout bristle. On each of the second and third thoracic segments is a pair of dorsal horns on each side, or four to each segment. The outer or subdorsal horns are only a little more than half as long as

the inner, but otherwise like the latter; the trunks are spiny, the spinules minute, sharp, nearly equal in size, there being about fifteen to each trunk or stem of the spine. The singular bulbous termination is flattened, rather deeply divided, but somewhat like a chestnut in shape, but wider in proportion, and each side is produced, ending in a blunt spinule, with a stout thick base; the trunk is umber-brown, but the bulbous extremity is blackish brown.

On being touched the larva jerks its head and front body sideways vigorously.

Each of abdominal segments 1–7 has a pair of smaller sharp spines about one-third as long as the longest thoracic spines, which are bent just beyond the middle where it sends off a spur; the end bearing a stout, not very long bristle. Besides these there is a pair of subdorsal spines and a lateral smaller one situated above the insertion of the legs, or six spines to a segment. There is a single median spine on the eighth segment just like the shorter outer ones on the thoracic segments in shape and color, and ending like them in a forked bulbous expansion. Also on the ninth segment is a smaller, shorter, single median dorsal spine, but regularly forked at the end, not swollen. On the tenth segment near the base are two stout, short spines, ending in four branches. Behind them at the end of the suranal plate are four minute spinulose piliferous spines, which are black, all the others in front being brown. The large, broad, squarish anal legs are corrugated on the side. All the legs, thoracic and abdominal, are black. The specimens died before molting.

Fig. 5.—Armature of *Citheronia regalis*. Stage I. *a*, the first abdominal segment, showing the relative position of the spines; *sp*, spiracle; *b*, one of the dorsal prothoracic "horns;" *c*, one of the dorsal horns of the third thoracic segment; *d*, one of the dorsal abdominal spines, those on segments 1–6 not differing in size or structure, near the base are two minute blunt setæ; *e–h*, the armature of the last three abdominal segments; *e*, the caudal horn; *e'*, the subdorsal spine of the same (eighth) segment; *f*, one of the dorsal spines of the ninth segment, which is evenly forked at the end; *g*, one of the large lateral spines arising from the suranal plate (x); *h*, the end of the suranal plate. All the figures drawn with the camera to the same scale.

The following description is drawn up from specimens bred at Providence, and described October 10. They fed on hickory, and were sent to Mr. Bridgham from Georgia.

Stage II (?).—(Probably Stage II, as the increase in size between the later stages is very marked.) Length, 25 mm. The head (width, 2.8 mm.) is rather large, rounded, as wide as the body, smooth and shining, mahogany brown, with two faint black shades converging towards the apex. The body is somewhat slender, the skin smooth and dull flesh-brown, with smoky blackish marks, the spines and spinules a little paler than the body and tipped with black. The prothoracic segment is broad, the front edge raised and flaring, with a transverse row of six black spines,

four dorsal and one subdorsal; of the four dorsal the inner two are about as long as the body is thick, and sharp at the end, with long spinules; the two adjoining spines are minute. The four spines on the second thoracic segment are much larger, the outer ones on the second and third thoracic of nearly the same size, but the inner two on the third thoracic segment are a little longer than those on the second.

The spines on abdominal segments 1–8 are of even size, and armed with long spinules; they are about two-thirds as long as the body is thick, and end in two long diverging spinules. On the eighth segment, arising from a large, fleshy base, is a much spinulated caudal spine, nearly half as long as the large thoracic ones; it is mostly black, but flesh-colored in the middle. Behind it, on the ninth segment, is a median dorsal horn, about one-third as large as that on the eighth.

The suranal plate is small, rough, bearing two large spines; the end is rounded, with two minute spines between the last pair of lateral spines; the anterior two of the spines on this plate are larger, but simpler than those on the ninth abdominal segment, and end in four spreading spinules, the main stem being nearly smooth.

The prothoracic segment is blackish, reddish dark flesh color in the middle; the second thoracic segment is of nearly the same color, but the third is entirely black. The stigmata are black, surrounded by a blackish cloud, while in front is a velvety black oblique dash, and beneath a flesh-colored oblique raised ridge or fold. All the legs, both thoracic and abdominal, are black; the anal pair are large, rough and black. There is a large spine under each spiracle.

Stage III.—Length, 30–35 mm. Molted on the morning (9 A.M.) of October 10. When first seen the color of the body was uniformly purplish flesh color, with black markings. The head (width, 4 mm.) is dark chestnut brown, with the clypeus and adjoining parts pale. *It differs from the preceding stage in the considerably shorter abdominal spines, while their spinules are somewhat larger in proportion than in the previous stage.* The thoracic spines are about, or a little more than, twice as long as the body is thick, and the abdominal spines are about one-third as long as the body is thick. The lateral oblique fleshy fold on the abdominal segments have a more distinct dark dash above than in the preceding stage. The legs are black. The caudal spine is now about one-third as long as the larger thoracic ones, being in the former stage about, not quite, one-half as long as the longer thoracic spines.

By 2 P.M., October 10, the thoracic and caudal spines, at first pale flesh color, became black, and the head and thorax, as well as the body generally, had turned darker.

It assumes, like *E. imperialis* and *S. bicolor*, a Sphinx-like attitude, so that this feature is possibly inherited by the Sphingidæ from the Ceratocampidæ or a similar group. The thoracic and caudal spines are somewhat sensitive to touch by an intruder.

Last Stage.—I will first describe an alcoholic specimen, 45–50 mm. in

length, which at first I thought must belong to a fourth stage, or at least one before the last, but as the head is of nearly the same size as full-grown specimens, I am inclined to regard it as simply a belated individual, or one which had recently molted, and had not fed up so as to fill out to its full size.

Length of body, 45–50 mm.; breadth of the head, 6.5 mm. The head is yellowish brown, with a dark spot on each side of the head opposite the apex of the clypeus. The two dorsal prothoracic spines are nearly as long as the head is wide, but without the long slender spinules of the previous stage; they are yellowish, but black on the distal third; the third or metathoracic pair are a third longer than the body is thick, and like the others, with short, stout spinules. The abdominal spines are now much shorter than before, with short spinules, though slightly longer than in the fully grown examples. The "caudal spine" on the eighth abdominal segment is as in the full-sized specimens. The general hue of the body is as in the full-grown larva, but the thoracic dorsal black spots are smaller, though the metathoracic segment in front of the horns is deeply stained with black.

Full-grown Larva.—Length, 125 mm.; thickness of the body, 20 mm.; width of head, 7 mm. The head is about one-third as wide as the body rounded, smooth, free from hairs, and yellowish, not spotted on the sides, and not banded as in *Eacles imperialis*. The body is cylindrical; the skin smooth and shining, not granulated, as in Sphingicampa and Eacles. The two middle prothoracic spines are large and long, being nearly as long as the head is wide, but the spinules, like those of the other "horns," are now short, thick and acute, not long and slender as in the previous stages; length, 6 mm.; they are yellowish and black on the outer third. This and each segment of the body succeeding have six well-developed spines, except the eighth and ninth abdominal, which have each an additional spine, the large median one. The two large median horns on the two hinder thoracic segments are each about 20 mm. in length; the horns of the second row corresponding to the subdorsal or supraspiracular row of the abdominal segments, being about half as long (10 mm.) as the dorsal ones; they are also yellowish and blackish on the outer third. All the six abdominal spines of segments 1–7 are now very small, slender and only about twice as long as the large dorsal horns are thick at the base; viz., 4 mm. in length. Unlike the full-grown Eacles, the supra and infraspiracular spines are as well developed as the dorsal ones. On the eighth and ninth abdominal segments the "caudal horns" are supplemented by two small, slender spines, situated just behind the large median horn. Whether these have any morphological significance is doubtful; they do not exist in Eacles. Length of the "caudal horn" on the eighth segment, 9 mm.; that on the ninth segment being one-half as long. The suranal plate is triangular, the surface rough, with two small tubercles on each side, but no spines. The anal legs are very large, subtriangular, with the outer surface rough, and on the

lower edge above the planta is a group of seven or eight minute spines; a similar group of minute spines occurs near the end of the middle abdominal legs.

For the colors the reader is referred to the description and figure by Riley, of the living animal, in the *American Entomologist*, i, 230. We have not yet seen a full-grown living larva. The foregoing description has been drawn up from four well-preserved alcoholic specimens.

This larva differs generically from Eacles in having well-developed dorsal spines on the prothoracic segment; while the lateral ones along the abdominal region are also well developed, these being nearly obsolete in Eacles. The genus Citheronia is unique in having seven spines on the eighth and the ninth abdominal segments respectively. All these characters are seen to be secondary and adaptive, and yet they are good generic characters, showing that the acquirement or loss of generic characters is due to adaptations to the surroundings. The specific characters are well brought out by comparing *C. regalis* and *C. sepulcralis*.

RECAPITULATION OF THE SALIENT FEATURES IN THE ONTOGENY OF CITHERONIA.

A. *Congenital Characters of the Larva, as seen in Stage I.*

1. The three pairs of enormous spines; the first or prothoracic pair but little shorter than the third, and the middle pair about two-thirds as long as the body, all ending in a swollen, triangular, two-horned flattened bulb; these appendages being deterrent and for offensive use in the earliest as well as latest larval life.

2. Both the eighth and ninth abdominal segments bearing a high median dorsal horn; and these segments bearing seven, instead of only five, spines.

3. The lateral spines on the abdominal segments nearly as large as the dorsal ones.

4. Body dark; head dark in color.

B. *Evolution of Later Adaptational Characters.*

1. The bulbous tips of the thoracic horns dropped at the end of Stage II (?).

2. The thoracic horns become curved in Stage II or III (?).

3. The thoracic dorsal spines become much stouter, with much shorter and stouter spinules at the last molt.

4. The mature larval features mostly assumed in Stage III.

5. The dark colors exchanged after the last molt for pale green, with bluish tints.

6. The black dorsal thoracic spots and the lateral yellowish bands most showy in the last stage.

Attention should be drawn to the colossal size of this larva, as compared with that of Sphingicampa and even Eacles, though the head is not so

much larger. This is due, perhaps, to its sluggish life, greater digestive and assimilative powers, so that a rapid acceleration of the growth of the body takes place; owing to its protection from the attacks of birds it may feed openly and continuously. It is thus like Sphingid and Attacine larvæ in its huge body and enormous appetite. The largest Cochliopod larvæ are the spiny ones, and the spiny or tuberculated Saturnians and Attacinæ have thick, large bodies.

FAMILY HEMILEUCIDÆ.

Notes on the Early Stages of Hyperchiria io (Fabr.).

At Brunswick, Me., the eggs were laid in confinement, June 5–7, and the larvæ hatched June 25, or about three weeks afterwards. Another year, larvæ in the second stage were observed July 16. For an excellent but brief description of all the stages see Riley's *Fifth Rep. Ins. Missouri*, 135; also Lintner's *Entomological Contributions*, ii, 146. Both authors state that there are six stages.

Egg.—Length, 1.8 mm.; width, 1.4 mm. It is regularly oval-cylindrical in form and slightly flattened; yellow during early embryonic life, with sometimes an orange spot on each side. Under a high-power triplet the surface of the shell is seen to be very finely granulated (not smooth and shining), and under a one-half-inch objective the surface is seen to be divided into close-set, very small, slightly raised but flattened areas, separated by narrow valleys; the areas are very irregular, but often are somewhat polygonal in outline.

Larva, Stage I.—Length, 5.5, when freshly hatched; the head, 0.8 mm. in width. The body is uniformly yellowish brown; the head and spines are dark, blackish brown. All the feet, both thoracic and abdominal, are of the same color as the body. The spines are in four rows, *i. e.*, there are eight on each segment, except on those bearing the abdominal legs, when the smallest or infraspiracular ones are wanting. The eversible glands are well developed; a pair on the first and a second pair on the seventh abdominal segment; they are situated behind the spiracle of their segment and between the subdorsal and spiracular row of spines. The spiracles are very small and hard to detect in this stage. The subdorsal spines are about as long as the body is thick, the dorsal ones a little thicker and longer; they end in usually fine setæ, one of which is finely barbed about as long as the spine itself. Both the subdorsal and dorsal spines of the three thoracic and of the eighth and ninth abdominal segments are deeply forked, the forks of equal length and each bearing the long bristle as well as four or five short ones. Those of the other segments are not forked. The first thoracic dorsal and subdorsal spines are as long and large as those on the two hinder segments. The spines are represented in Fig. 6.

Fig. 6 represents the freshly hatched larva, drawn with the camera, with the lateral, eversible glands (*g*).

Fig. 7 represents the armature of the three thoracic segments. *Pp*, the prothoracic shield; I, II, III, the bifid dorsal spines of the three thoracic segments, about three-fourths or four-fifths as long as the segments are thick; *sd'*, *sd''*, *sd'''*, the bifid subdorsal spines; *s'*, *s''*, *s'''*, the spiracular spines; the prothoracic ones throw off a bristle near the middle; in those behind this bristle is wanting; they are inserted just in front of the spiracle, the corresponding ones, however, on the abdominal segments being situated just below the spiracles; *i'*, *i''*, *i'''*, the small infraspiracular spines which are about half as long as the spiracular ones; *l'*, *l''*, *l'''*, insertion of the thoracic legs.

Fig. 8 represents the armature of some of the other segments. A, the third thoracic and the first and second abdominal; III, I', II'', the dorsal spines; and the other lettering as before; *sp*, the spiracle; *g*, the lateral eversible gland of the first abdominal segment. B, the sixth to tenth (and last) abdominal segments; faint traces of the spiracular and infraspiracular yellowish lines are to be seen, hence the medio-dorsal, the subdorsal, and the two lateral longitudinal lines of the larva in its second stage are already indicated in the first stage. The abdominal legs each bear eight ungues, or four on each side; and all except the anal legs bear a piliferous wart just above the planta; *sp*, the rugose suranal plate, bearing five piliferous warts on each side; *lp*, the lateral plate of the anal legs, with three or four piliferous warts.

Stage II.—Length, 7 mm.; width of head, 1.3 mm. The head is chestnut-brown. The body is uniformly reddish amber-brown; the spines are blackish brown, with the spines black at the tip. *The dorsal and subdorsal spines are now approximate in shape to those of the last stage, being bulbous at base, and with radiating stout spinules, but the latter are less in number than in the fifth and sixth stages.* The dorsal spines of the prothoracic segments are bifid, the forks of the same length, and each bearing a long hair; along the trunk are pale scattered tubercles, each ending in a long hair. The second thoracic dorsal spines have but one terminal piliferous spinule and a single lateral one, the other spinules ending in a sharp black point. The third thoracic is like all the abdominal dorsal spines which bear radiating spinules, not ending in a single piliferous spinule, as in Fig. 9, *vi*.

Fig 9, *sd'''*, represents a spine of the subdorsal series, the one figured being that on one side of the third thoracic segment, but those on the abdominal segments (except x) are like it, though most of the abdominal ones have two or three small tubercles near the base which bear barbed bristles, as at *sd^vi*. All the long setæ bear a few minute barbs.

In Stage IV (?), when the larva is 20 mm. in length, the prothoracic dorsal spines are nearly twice as long as the second thoracic; the latter, however, have more spines at the base than those in front, and the lateral terminal are a little shorter than those on the first thoracic segment. The two dorsal spines on the third thoracic segment are, in size and spinulation, now exactly like those on the abdominal segments 1–9. The

median double one on the eighth abdominal segment is thicker than the single ones in front, also higher, and ends in two spines; the lateral spines are much more numerous than those in front. The spines of the subdorsal series are alike on both the thoracic and abdominal segments.

Last Stage.—The shape of the dorsal spines of the larva in its final stage is represented by Fig. 10. I, a prothoracic dorsal spine, ending in two equal terminal piliferous spinules, with seven or eight just below it, while at and near the base are the long, pale spines, each ending in a sharp black point; II, one of the second thoracic dorsal spines, the base short, bulbous, with very numerous radiating spines, and a single terminal, central piliferous spine, with a smaller one near it; III, a bush-like dorsal spine of the third thoracic segment, no piliferous spinules present. The abdominal dorsal spines are all on the same type.* The median spine on the eighth abdominal segment is about twice the size of the other dorsal single ones in front, though no higher, and it spreads more, having about twice as many spines on the sides. On the ninth segment are two dorsal and two subdorsal ones, and behind these four on the same segment is a median one. *These types are already attained in Stage II, though the spinules are fewer in number.*

It is to be noticed that the characters of the full-fed larva appear in large part in Stage II, and are almost fully developed in Stage III.

Fig. 11 represents the spiracle and lateral eversible gland of the full-fed larva; *g*, the eversible gland; *sp*, spiracle; *g'*, an eversible gland, enlarged.

In the large dark (in alcohol) larva of Hyperchiria, or perhaps of a Gamelia, referred to by me in *Proc. Bost. Soc. Nat. Hist.*, xxv, 91, the dorsal spines of the three thoracic segments are represented by Fig. 12. I, a prothoracic; II, one from the second thoracic; III, one from the third thoracic; VII, one from the seventh abdominal segment. It will be seen that the spines of this species are rather more generalized than in the mature *H. io*, and approximate those of the second stage of that species; the dorsal spine of the third thoracic segment ending in three piliferous spinules, there being no piliferous spinules at all in the homologous spines of *H. io;* the abdominal spines also (VII) ending in three piliferous spinules, though the other spinules are much (about one-half) less numerous.

Intermediate between those of *H. io* and the Mexican species is the *Hemileuca artemis*, from Las Cruces, New Mexico (Fig. 13), in which the prothoracic dorsal spine is like the Mexican form, the second thoracic dorsal spine like the prothoracic ones of *H. io*, and the third thoracic dorsal tuft like the second dorsal one of *Hemileuca yavapai* from Arizona (Fig. 14). In this last species the dorsal tufts of the body, as a whole, are intermediate between *H. maia* and *H. io*, but as regards the second and third dorsal and the dorsal abdominal ones, it approaches much

*The spines have been somewhat flattened in the animalcule box, but have been drawn with the camera.

nearer to *H. io*, as will be seen by an examination of the figures, the second and third thoracic spines being alike in shape. Hence the most generalized or primitive form, as regards its larval armature, appears to be the genus Hemileuca, and *H. maia* is the most like the young larva of *Hyperchiria io;* then succeeds the Cordova larva, then the New Mexican larva, while *Hemileuca yavapai* is more modified, *Hyperchiria io* being the most so of any under consideration and this may have been the last to be evolved.

The Young Larva of Hyperchiria io var. Lilith (Strecker).

About a dozen living specimens of these interesting caterpillars were kindly presented to me by Mrs. Annie Trumbull Slosson, who had collected them at Punta Gorda, Fla., where they were found in March feeding on the mangrove. They were described April 6. Mrs. Slosson considered them as belonging to Strecker's var. Lilith.

Length, 20–25 mm. The body is yellowish green all over. The lateral broad, reddish, spiracular band is as in northern specimens of *H. io;* it is broadly and distinctly bordered below with white. The head and all the legs, both thoracic and abdominal, are straw-yellow. The spines in general are bright, straw-yellow, more yellow than the body; the ends of the dorsal ones on the prothoracic segment are black, while the ends of the long spinules in general are more or less black, some merely tipped with black.

This is apparently a case of acceleration of development, as *the larva in its second (or third) stage resembles in coloration the full-grown northern form of the larva of H. io*, the markings, including the lateral reddish and white spiracular line, being as in the full-fed normal larva of *H. io*, and the general color of the body and spines being yellow, instead of gray and reddish, as in the normal *H. io* in its second and third stages.

Notes on Hemileuca maia (Drury).

Stage I compared with that of H. io.—In this stage *maia* is very similar to *io;* only the bifid dorsal tubercles or spines have shorter branches, the spines themselves being a little shorter, while the longest bristle is longer, the other bristles arising from the end of the spines being fewer, indeed only one, instead of three or four, as in the abdominal segments of *io*. The medio-dorsal spines on the eighth and ninth abdominal segments are much shorter and with a shorter fork, but with as long or slightly longer bristles arising from the forks. The larvæ of the two forms are of the same size.

Stage II (or III?).—Maia in what appears to be the second stage differs from *H. io* in its second stage in having much longer dorsal spines, with very much longer spinules. *Thus the generic characters appear in the second stage, as in H. io.*

The Larva of Hemileuca artemis sp. nov.*

Several full-grown larvæ were received from Las Cruces, New Mexico, kindly sent me June 15, 1891, by Mr. C. H. Tyler Townsend; they were found feeding on a species of long-leaved willow, and on a populus. Mr. Townsend writes regarding these caterpillars:

"I am informed that in previous years this caterpillar has been extremely abundant here, almost denuding the cottonwoods (*P. fremontei*). They are said to appear in force later in the season. I rather doubt this, but will look out for more."

Mature Larva.—Length, 45 mm. The body is long and thick, of the general shape and thickness of *H. io*, rather than of *H. maia*. Head dull shining red, about half as wide as the body in the middle. Segments of the body each with an irregular, deeply impressed, transverse wrinkle, just behind the middle. A moderately large prothoracic plate, which is irregular in shape and divided in the middle into two pieces; it is dull reddish honey-yellow or chitinous in color. On the prothoracic segment are eight large, high-branched spines, as large as any of the others on the body behind; they are black, with the spinules black at base, pale flesh color beyond; the terminal bristles are dark; there are about 16–18 spinules on each spine, nearly as in *H. maia*, and the prothoracic spines of *H. io*. The spines on the second thoracic segment are similar in shape and length to those in front, but slightly shorter and with a smaller number of spinules towards the end. On the third thoracic, to and including the seventh abdominal segment, the two rows of dorsal spines are like those of *H. io* behind the prothoracic segment, being short, thick, bushy spines, with numerous radiating, yellow spinules, which are black at tip. On the eighth segment there is a single, slightly larger one, with two central spines, one on each side. Those on the ninth segment are like the prothoracic ones, the median one being of the same size as the lateral ones. There are no spines on the tenth or last segment. There is a subdorsal and an infraspiracular row of spines like those on the first thoracic segment along the sides of the abdomen, but on the thoracic segments are two rows of infraspiracular spines. There is a rather large, broad, V-shaped or short subcordate plate on the tenth segment of the same color

* *Hemileuca artemis* sp. nov. 1 ♀ with wings not fully expanded. At first doubtfully referred to *H. juno*, I find on comparison with my types in the Museum of Comp. Zoölogy at Cambridge that it is quite different. The head and body are larger. The thorax is much more white, both on the prothorax and on the patagia, which are entirely white. The disk of the mesothorax is brown; the two tufts, one on each side behind, are orange-red, instead of claret-red as in *juno*, and the hairs between the forelegs and those on the fore femora are of the same deep orange-red as the thoracic tufts. *Juno* has more reddish hairs on the end of the abdomen, where they are all white in *artemis*. The fore wings are white, with a black-brown border all around, completely enclosing the entirely opaque black-brown discal spot, which, in the unexpanded specimen, does not enclose (as it does in *juno*) a lunate white spot. The blackish costal edge is as wide as the outer edge. The hind wings are apparently much as in *juno* and in *grotei*. It does not agree with the description of *grotei* (*Trans. Amer. Ent. Soc.*, II, 192, Pl. II, Fig. 60, 1868).

as the prothoracic plate, and a bristly, concolorous plate on the outside of the anal legs.

The body is smooth, without the granulations of *H. maia* and without the lateral reddish band of *H. io*. The body is pale, sea-greenish, with irregular brown spots and slashes in the spaces between the spines of the subdorsal rows, and they also occur lower down near the spiracles, which are yellow, edged with dark brown. Thoracic legs dark honey-yellow; abdominal ones washed with cherry reddish.

The eversible glands were not everted in any of the six specimens, but their position is indicated, as in *H. maia*, by an irregular oval, liver-colored patch behind the first thoracic and eighth abdominal spiracles.

Fig. 13 represents the dorsal spines of the three thoracic segments respectively. I, one of the dorsal prothoracic spines, in which the spinules, with long setæ, are scattered along the whole length of the main trunk; II, one of the dorsal spines of the second thoracic segment, surrounded at the base by a dense thicket of acute spinules, the latter not bearing a terminal seta; III, a dorsal spine from the third thoracic segment, forming a short, broad tuft or clump of non-setiferous, but acute spinules, the clump having a broad base, from near the centre of which arises a long spinule, bearing a slender seta, like those near and at the ends of those in front. The two dorsal rows of abdominal spines extend back to and including the seventh uromere.

FAMILY LASIOCAMPIDÆ.

On the Flattened and Scale-like Hairs of the Lasiocampidæ.—Dr. T. W. Harris* describes an Acronycta larva, *A. americana*, as "beset with a few long black bristles dilated at the end," and again says, "the long, black, spear-headed hairs grow from the skin and not from warts." A year or more ago, in examining the median dorsal tufts on the second and third thoracic somites of the European *Gastropacha quercifolia*, I found that they were composed of broad lanceolate oval scales, which were opaque and dark steel purple in color, with the surface quite regularly striated, though not invariably so. The striæ do not appear to extend to either end. They vary in shape and in size, some being narrow and with a simple point at the distal end, while the majority are variously notched or toothed, as shown in Fig. 15. They thus appear to be true scales, like those on the wings of Lepidoptera, etc.

In the same species the lateral tufts along the body contain each a few long hairs with flattened ends, the latter varying in shape from oval to triangular, with the ends often very broad and ragged, with from one to four very irregular teeth. No striæ are perceptible, and the hairs throughout are pale, colorless and transparent (Fig. 16).

* *Entomological Correspondence of T. W. Harris*, edited by S. H. Scudder, Boston, 1862, Pl. iii, Fig. 2. The same larva has also been figured in my *Guide to the Study of Insects*, Fig. 236.

Fig. 15.—Scales from the dorsal thoracic tufts of *Gastropacha quercifolia.*

Fig. 16.—Hairs with flattened ends, all from a single lateral tuft. *a*, a hair ending in two slender points, the only one seen.

On examining the lateral tufts of *Gastropacha americana*, I found some very long similar hairs flattened at the end and of extraordinary form, usually projecting beyond the simple hairs; some ending in regular lanceolate-oval shapes, with the point much attenuated, others broader, while some are oval and broad at the end, which terminates in a fine attenuated point, with usually three minute teeth at the base. They are similar in shape to those of *Gastropacha quercifolia.*

On turning over the beautiful plates of Burmeister's Atlas of the Lepidoptera of the Argentine Republic, I found that the author represents on Pl. xxii, Fig. 9, similar long hairs, much flattened and expanded at the ends, with 3, 4 or 5 long slender teeth, in the larva of his *Clisiocampa proxima*,* which, however, seems to differ from Clisiocampa proper. The hairs are visible to the naked eye, and are much more regular than any I have seen, and are also striated, with beads or clear spots.

In *G. americana*, the scales forming the dorsal tufts both on the two hinder thoracic segments and on the eighth abdominal one are very different from those of the European species; they are dark and opaque, but are long, narrow, flattened, very gradually increasing in width to the end, which has a single notch, and from the single notch an impressed line or stria extends along the middle for some distance.

Fig. 17.—Scales from the tuft on the dorsal tubercle of the eighth abdominal segment. *a*, the setæ × ⅓ in. obj.; *b*, *c*, similar ones × ⅓ A eyepiece.

Fig. 18.—Flattened hairs from the lateral tufts of the second and third thoracic segments of *G. americana*, color pale brown.

These flattened hairs seem common to the family of Lasiocampidæ, and should be looked for in the European species of this group. In *Heteropacha rileyana* there are no dorsal scales, but some of those in the lateral tufts have flattened ends, which are very long and slender, lanceolate-oval, with the tip much attenuated.

Fig. 19.—Flattened hairs from the lateral tufts of the second thoracic segment of *H. rileyana.*

I have been unable to discover these singular scales and flattened hairs in *Clisiocampa americana*,† or *C. neustria* of Europe, or in any other family

* Burmeister (p. 52) remarks: "Stoll has figured (Suppl. de Cramer, Pl. xix, Fig. 5) a similar larva with the same hairs, d *palmelle terminale*, situated on the first and last rings of the body." He names it *Bombyx ephonia* (Pl. xxxv, Fig. 6, of the same volume). Walker refers this species with doubt to the genus Oxytenis. Burmeister adds: "Some other species of the genus Clisiocampa have the same hairs placed at the two ends of the body."

† In *C. sylvatica* the hairs on the lateral thoracic tubercles are tapering and finely barbed, with scattered slender spikes like smooth simple setæ.

In *Tolype velleda* there are no such scales or hairs with flattened ends as in Gastropacha, those on the dorsal tubercles of the thoracic and eighth abdominal segments being simple, tapering, with large scattering spike-like dark opaque setæ, these latter being perhaps the homologues of the dark scales of Gastropacha.

of Lepidoptera, except in the hairy Noctuina or Noctuo-bombyces, or Bombycoidea, where the hairs with flattened ends probably occur in the more hairy and penciled species. In the larva of the common American *Acronycta hastulifera*, many of the barbed hairs forming the black pencils are flattened at the end and black, but not striated.

Fig. 20.—Flattened setæ of various shapes, usually pointed. *a*, a small one; *b*, its barbed base; *c*, portions of the white barbed hairs; *d*, one blunt and notched at the end; all × $\frac{1}{5}$ in. obj., and from tuft on the third thoracic segment of *A. hastulifera*.

These specialized and highly differentiated setæ, so like the scales of adult Lepidoptera, appear to be of use in rendering the pencils and tufts more conspicuous and stiff. The shortest and broadest, striated, scale-like setæ occur on the low, broad, stout, dorsal median tubercles of Gastropacha; and, perhaps, add a repellant nature to these shiny dark metallic tufts. At all events the occurrence of such scales is an interesting example of the acceleration of development of the setæ in these larval forms, and it is not improbable that in the ancestors of the Lasiocampidæ they were characters acquired during the later stages of their larval lifetime.

Partial Life History of Clisiocampa thoracica (Stretch).

Specimens in the third (?) stage were mailed April 28 from California by Mr. L. E. Ricksecker, and received and described May 5. It was feeding on willow leaves, but will eat sparingly of the eastern wild cherry. It has the same habits as the eastern *C. sylvatica*, spinning a web and living in clusters.

Larva, Stage III(?).—Length, 10–12 mm. In this stage it closely resembles *C. sylvatica* when next to the last molt, both in the shape and color of the exclamation-point-like pale dorsal spots; in having on each side an ochre-brown subdorsal line, though it is more broken, and a distinct, broad, lateral line, which is edged above and below with black. Below this line, low down on the sides of the body, are two whitish, reddish-yellow, wavy, irregular thread-lines, the lower one a little more distinct and pale tawny. The upper of these two lines is present in *C. sylvatica* (but the lower one is not present in Bridgham's drawing). The space between these two lines is somewhat livid, with pale blue and black dots.

The head is pale blue, with fine black dots, which are thickest on each side of the median line, and in the middle of each side. The prothoracic segment is bluish, with a median black hair-line, with two converging, lateral, black patches in front, and two shorter ones behind. The hairs on the body are deep tawny, those on the sides, low down, mixed with gray hairs.

Stage IV(?).—Length, 20 mm. Molted about May 10, observed from May 11 to 16. The marks and spots, especially the blue ones, are much more distinct than before. The black dots on the head are arranged more regularly than before, forming a triangular area on the vertex and

including the median suture, while there are two areas on each side containing the black dots, the lower group situated behind the eyes. The yellowish-white dorsal, median, exclamation marks are on a black field. The broad, now very distinct sky-blue subdorsal line is irregularly edged with black and above and below with a distinct, ochreous, wavy line. The blue line is, on the second and third thoracic segment, interrupted by a conspicuous square black spot, and a similarly situated black dot in the middle of each segment appears on the lower edge of the blue band, being a local dilatation of the lower black edging of the blue band. The eighth abdominal segment is slightly humped, and on the side the subdorsal blue band ends in a squarish black spot. The two lower ochreous lateral lines are distinct, the lower one extending along the base of the legs. The hairs are now snuff-colored; those on the sides, low down, being mixed with whitish ones.

Stage IV (?).—May 18 it molted again, its length being 18–21 mm. It is now quite different from the former stages. The yellowish-white exclamation point is now less distinct, the dot often obsolete, and the mark is now ochreous and white in the centre. The previously black dorsal band enclosing the median series of exclamation marks is now partly filled with blue specks, and *contains traces of a much interrupted wavy, deep reddish ochreous line.* The lateral blue lines and sides of the body in general are scarcely different from the former stages, though the red thread lines are deeper in hue. The hairs above and on the sides are now rather denser and more decidedly snuff yellow (the short, red, wavy lines in the dorsal spaces are new to this stage).

Final Stages of Clisiocampa thoracica (Stretch).

Received living from Mr. Ricksecker, May 5, having been fed on willow. Length, 28–30 mm. This belongs to the same stage as that described May 18, in my notes, but the dot of the exclamation mark is less distinct, the markings are more distinct, and the larva is larger, and they feed better. The blue and snuff or deep ochreous wavy spots and short lines are more distinct. Of the very irregular blue spots there are three on a side of the dorsal space on each segment enclosed by the subdorsal, reddish, ochreous lines. The second or lateral line is now, instead of being reddish ochreous, decidedly yellowish ochreous. May 27, one has molted to the last (?) stage. This larva is interesting as passing through a *sylvatica* stage with its dorsal exclamation mark.

The following description is drawn up both from living specimens and blown ones loaned by Prof. Rivers and named *thoracica* by him.

Full-fed Larva.—Length, 45 mm. Head deep blue, with two series of fine black dots along the top, and another broader series along the sides; with a clear bluish space between. The prothoracic or cervical shield is more distinct than in any others of the California species which I have seen, as it is freer from hairs and marked with blue; it bears two black

dots in front and one on each side. There are four subdorsal, ochreous, rust-red, fine, wavy, irregular lines, which are broken at the sutures and enclose three still slighter and much less regular more broken dorsal lines. Near the front of each segment these three short dorsal lines more or less unite to form a conspicuous oval, dull ochreous-red spot, irregularly centred with a paler hue; the spots on the second and third thoracic segments being paler and running more into each other. The ground color of the body is dull bluish, with black specks. The dot of the dorsal ochreous exclamation mark is now nearly or quite obsolete, sometimes represented by a few scales or irregular dots, and the main mark is itself sometimes irregular and reduced in size. On each side, just behind each exclamation mark, is a conspicuous black dot, and another similar pair behind, making four conspicuous dots, the anterior two more distinct than the others.

There are two irregular, subdorsal, wavy, Scotch-snuff-colored thread-lines edged with black. The pale sky-blue field of the back of each segment is divided by the two black spots into three bluish patches on each side of the dorsal area. The sides of the body blue, speckled with black. A lateral pale snuff line above the spiracles edged with black, which gathers in the middle into a dot, which is situated above the spiracle. A faint, double, flesh-colored, infrastigmatal line, very irregular, sometimes sending streaks towards the black spiracles, the lower of the two lines forming elongated patches at the base of the legs, the two lines being more or less confluent on the thoracic segments. In some specimens there is only a short, broken, snuff-colored line at the base of the abdominal legs; and a snuff-yellow dot on each side of the first thoracic segment.

The body is less hairy perhaps than in any of the other species. There are a few long, dark, dorsal hairs, with an undergrowth of fine ochreous hairs, and on the sides of the body below the spiracles are lateral, whitish gray, rather dense hairs, directed downwards. The hairs are longest on the thoracic and eighth abdominal segment, the latter being well swollen or humped on the back.

The body beneath is livid bluish, with pale flesh-colored patches on the front of each abdominal leg, except the anal pair.

This species differs from *C. fragilis* or *C. californica* in the rather less hairy body, and the four subdorsal rust-red lines, enclosing the three dorsal, short, rusty, broken lines which in front of each segment form a distinct, short, oval, reddish spot; and also in the distinct bluish cervical shield.

Clisiocampa constricta (Stretch).

The following description was drawn up from blown specimens kindly loaned me by Prof. J. J. Rivers, of the University of California.

Full-fed Larva.—Length, 46–48 mm. Head mottled with dull blue and black spots, the spots not arranged in lines, as they are in *C. thoracica*. The body is rather more hairy than in the other Pacific coast species, and

there is no distinct cervical shield. There is a dorsal row of about twenty ochreous rust-red patches, very irregular in shape, connected by two short parallel wavy lines of the same color. Each spot is situated on a deep velvety black field, ending behind in two conspicuous large black dots. From each red patch arise numerous hairs, forming a wedge-shaped ochre-yellow tuft. The ground color of the body is deep blue, spotted and mottled with black. There is a lateral row, one to each segment, of black dots, irregularly surrounded by ochre-red. Just below is a row of conspicuous short, thick tufts of white hairs situated near the front edge of each segment. Below each black spiracle is an obscure flesh-colored diffuse patch enclosing a small black dot, while beneath is a long black patch. All the legs, both thoracic and abdominal, and the under side of the body are livid blackish. The few dorsal hairs (the ochreous ones excepted) are black, those on the thoracic segments being longer than the others, while the lateral and ventral hairs are grayish, with an intermixture of ochreous ones.

The larva of this species differs from all the others of the genus known to me by the large, conspicuous, ochreous-red, dorsal spots giving rise to the peculiar wedge-shaped ochreous tufts, and by the lateral row of short white tufts, while the body in general is much more hairy than in the other species. No eastern species approaches it in these characters.

Clisiocampa fragilis (Stretch) (?).

This larva, referred with some doubt to the above species, was received from Mr. J. J. Rivers, who collected it in the Sierra Nevada. The following description was made from a blown specimen :

Full-grown Larva.—Length, 42–44 mm. Head bluish, mottled with heavy coarse black spots, with a tendency in their arrangement similar to that in *C. thoracica*. The cervical shield is very indistinct. The body is pale blue, with black specks and very irregular fine ochreous-red lines, more or less broken and confluent on the first three or four segments. The species is at once distinguished by the dorsal row of long, narrow, whitish-blue, distinct spots, beginning with the second thoracic segment, each spot extending nearly the whole length of the segment. On each side of the same segments are two large, conspicuous, irregular spots of the same color, beneath which is a band made up of broken, irregular, ochre-red hair-lines. The spiracles are situated in a broad bluish band. Body beneath black, with pale flesh-reddish or ochreous patches between all the legs, both thoracic and abdominal. There is a black dot near the base of the four median pairs of abdominal legs. The hairs above are rather denser than in *C. thoracica*, and ochreous ; those on the side are ochreous running into gray, those on the sides of the thoracic segments being whitish.

This larva is at once known by the conspicuous, long, dorsal, pale-blue, almost whitish blue spots, flanked on each side by two large, distinct, irregular spots of the same hue, with the space between conspicuously

deep black. Also by the numerous close, broken, fine, dorsal, alternating black and ochreous lines.

Two specimens of the same larva were collected by myself in the middle of June at Virginia City, Montana. It has the same markings, but the blue patches on the side are not so distinct, as they merge into the blue of the side of the body. On this account the black spots between the two blue patches is more distinct. In one example, however, the lateral blue spots are present. The markings on the head and the irregular ochreous-red lines on the anterior part of the body are just the same in the Montana example.

Partial Life History of Clisiocampa disstria Hübner (sylvatica Harris).

Of this caterpillar about a dozen described below were found on an oak leaf at Providence. May 24.

Stage III(?).—Length, 10 mm. Head not so wide as the body, black. The shape of the body is as in *C. americana* of the same age. The lateral prothoracic and other thoracic piliferous warts as in *C. americana*, but the markings are already very distinct. The prothoracic shield much as in the other species. There are four large, conspicuous, lateral, black, raised spots, two on the second and two on the third thoracic segment. The body is blue above, with two contiguous, parallel, broken, black lines, each dorsal bordered externally by a broken, deep, straw-yellow line, which widens on the sutures. *These black lines are wide, and in most of the specimens so encroach on the blue band, on abdominal segments 1-7, as to break it up into a median row of more or less pear shaped blue spots, which are diagnostic of the species*; thus the specific characters appear in this stage. Two lateral, linear, white lines enclosing a broad, blue stripe, the latter edged with a fine, broken black line. Abdominal segments 8 and 9 dull, livid blue. The body beneath is pale, livid, whitish. The thoracic legs are black; the abdominal legs with a black spot on the outside near the end.

The body is not quite so densely hairy as in *C. americana*, but the hairs are of about the same color, being pale brown above and whitish on the sides of the body and beneath.

In these examples the row of dorsal spots are seen to originate from the breaking up of the median blue band, owing to the encroachment of the black border.

Life History of Clisiocampa californica (Pack.).

I owe to the kindness of Mr. Cockerell a mass of eggs received from West Cliff, Custer county, Colo, and which hatched at Providence, April 14-15.

Larva, Stage I.—Length, 3 mm. Head and body of nearly the same proportions as in *C. americana*, but decidedly thicker and stouter, though

no longer. The color of the head and body are the same, being dull black, the head somewhat polished. The hairs are white, uneven in length, and, as in *C. americana*, a few are yellowish gray. The piliferous warts are distinct and rough. There is on each side of the median line of the body a row of about seven small but distinct, transverse, snuff-yellow dorsal spots, beginning on the first abdominal and ending on the seventh segment, there being more to be seen on the thoracic segments; they almost form a transverse linear spot, but are interrupted on the median line, though often continuous on the hinder edge of the segment, yet sometimes they are separate and the spots are narrowly triangular, the apices pointing outward away from the median line of the body.

Stage (?).—Length, 25 mm. The distinctive marks of this stage is *the row of lateral, black, elongated spots, sometimes broken into two portions, and then resembling a short, thick exclamation mark.* There is a diffuse, irregular, double black-brown dorsal band, enclosing on each segment an irregular, elongated, pale blue dash, which is more or less spindle-shaped, and ending in a point before reaching each suture. The clear, pale-blue sides of the body are also speckled with fine black dots.

Also in the last (!) stage the short, irregular, sienna or deep ochreous brown lines in the dorsal black bands become obsolete.

It differs from the eastern *C. sylvatica* in the dorsal median spots being pale blue; in the obsolete, ochreous, lateral lines, and in the much larger, lateral dark spots, while the entire side of each segment is pale blue, not gray below.

C. californica is in a more advanced larval stage than *C. sylvatica*, and should stand above it, the lateral black line disappearing, being broken up into spots, and the dorsal ochre lines being obsolete. It is thus a more specialized form. The larvæ eat sparingly on willow and aspen, living until July 15.

I received a bunch of eggs from Mr. Ricksecker, of Santa Clara, California, April 7. Some of the larvæ hatched on the journey east; they seemed unable to eat their way out. I assisted one by removing the uneaten rim, and as it came out the hairs were still moist and lay along the back; several (those arising from one wart) stuck together before it was able to extend the end of the body and to walk away. In four or five minutes the end of the body became extended, and it began to walk. The head and body are dull black; the hairs grayish white; the ochreous dorsal markings not yet to be seen.

The larvæ described below were received from Miss Morton, June 4. Do not eat willow, but feed on oak.

Stage II.—Length 10 mm. (after first molt). The body and head are of the same shape and proportions as in *C. americana* and *sylvatica*, but with the dorsal piliferous warts more distinct; a pair of dorsal warts on each segment, making two distinct rows, between which are two parallel broken, irregular, snuff-yellow, thread lines, beginning on the third thoracic and ending on the seventh abdominal segment. The body is dull

livid blackish, with a dull bluish tint. The sutures are smooth and shining; hairs reddish brown. The eighth segment is scarcely humped.

The duration of this stage was about 6–10 days, as it molted the second time June 10–14.

Stage III.—Length 14–15 mm. (after second molt). *The body is now distinctly deep blue and black;* the two yellow-brown dorsal lines are still more broken up. *On the side of each segment the blue contains a distinct longitudinal, somewhat pear-shaped black spot,* preceded in front by a black dot, like a short, thick exclamation point. The hairs are distinctly snuff-brown. *A dorsal median row of blue linear stripes, separated by the sutures.*

Remarks on Clisiocampa californica.—In two alcoholic, full-grown larvæ, length 36–38 mm., which I collected near Virginia City, Montana, the distinguishing marks are the two irregular, wavy, parallel dorsal fine tawny red lines, which, in my alcoholic specimens, enclose a faint blue median stripe, one on each segment, so that I think my Montana "(?) *fragilis*" is only a variety of *C. californica.* (In the third stage, Mr. Bridgham's figure of the Coloradian specimens, the median blue stripe is very distinct, becoming fainter in the fourth stage.) The parallel, tawny, reddish lines are very irregular, sending off short twigs and branches, and on the hinder edge of each segment there are short, broken, irregular, subdorsal, tawny-red lines. The body is unusually hairy, the dorsal hairs being tawny reddish. The body beneath is mottled and irregularly streaked with blackish and paler lines and marks.

In Stretch's "(?) *fragilis*" the two blue spots on each side, and in my specimens, are merged into the blue of the side of the body, but in another example they are distinct, and in the alcoholic Montana examples they are wanting. I am, therefore, inclined to think that "(?) *fragilis*" is only a variety of *californica.*

In one alcoholic specimen from Montana, the two blue spots on the side are just as in "(?) *fragilis.*"

Notes on Variation and on a Variety of Clisiocampa californica.

The Californian species of Clisiocampa seem to vary more in the larval state than our two eastern species, probably on account of the greater variety of climate, especially *C. californica,* which occurs in Montana, Colorado, Southern Nevada, and in the lowlands of California, thus extending over a vast region whose physical geography is very much varied, while it has different food plants. It is not improbable that *C. constricta,* in which the hairs and sides of the body are somewhat alike, has been derived from *C. californica.*

In a blown larva loaned by Prof. J. J. Rivers, the following remark is written on the label: "Supposed to differ from *C. californica.*" It is probably only a variety, and allied to a blown larva labeled by Mr. Rivers "(?) *fragilis,*" and kindly lent me by him. The hairs, ochreous

above and gray on the sides, are just as in *C. californica* and "(?) *fragilis*," but the dorsal pale-blue lines are nearly obsolete, being, however, present, though narrow, on the second and third thoracic segments, and on abdominal segments 4–7. The dorsal ochreous-red lines are present in front, but obsolete on the posterior half of the body.

It is characterized by a narrow, distinct blue streak on the side of each abdominal segment, extending from the lateral pale-blue stripe up into the dark-brown subdorsal region. There is a minute blue dot in front of the much more distinct streak, and these two spots are the remnants of the two normal lateral pale-blue dots of *C. californica* and "(?) *fragilis*."

Larva of a Clisiocampa not californica.

Received from Santa Rosa, Cal., from E. L. Ricksecker, April 20. The cast skin of the head of a larva of the first stage was found in the box.

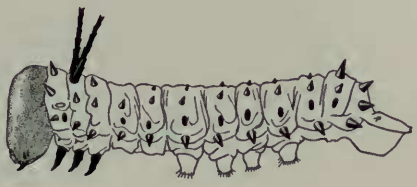
Stage II.—Length, 3–4 mm. Head large, considerably wider than the body, including the first thoracic segment; black. Body dark, with a distinct, firm subdorsal and two lateral pale, snuff-yellow lines, the upper lateral one being the more wavy and thread-like. The subdorsal lines send in yellowish points or dilations along the sutures. A dorsal row of dull blue elongated spots, that on the second thoracic segment larger and shorter and broader than the others. The blue spots are wanting at the end of the body, the one on the eighth abdominal segment not so distinct as the others in front. The dorsal hairs are long and unequal, snuff-yellow brown; those low down on the side being gray, and uniformly shorter than those on the back.

Life History of Clisiocampa americana (Harris).

From a mass of eggs found on the apple at Providence, and several of which hatched April 14, one was seen, April 15, to make its way out of the egg. The hairs, immediately after the shell is broken open, stand up as erect and stiff as a few hours later, not being soft, flabby and matted together as often seen in hairy or spiny larvæ, such as the Attacinæ.

A brood of larvæ in the second stage and 5 mm. long was noticed in the crotches of apple and wild cherry trees at Providence, April 26.

Larva, Stage I.—Described when from ten to twenty-four hours old. Length, 2–3 mm. Head moderately large, as wide as the second and third thoracic segments, shining black, with numerous long, uneven white hairs. The prothoracic segment is a little wider than the second and third and than the head, and the lateral piliferous tubercle projects so as to add to the appearance of the width of the segment. From this segment the body narrows very gradually backward to the end. The body is wholly dull black, clothed with white hairs which arise from minute but yet distinct rough warts. While the sutures are livid and the front edge of the prothoracic segment is also livid, I can see no traces of any other colored spots like those of *C. californica*.



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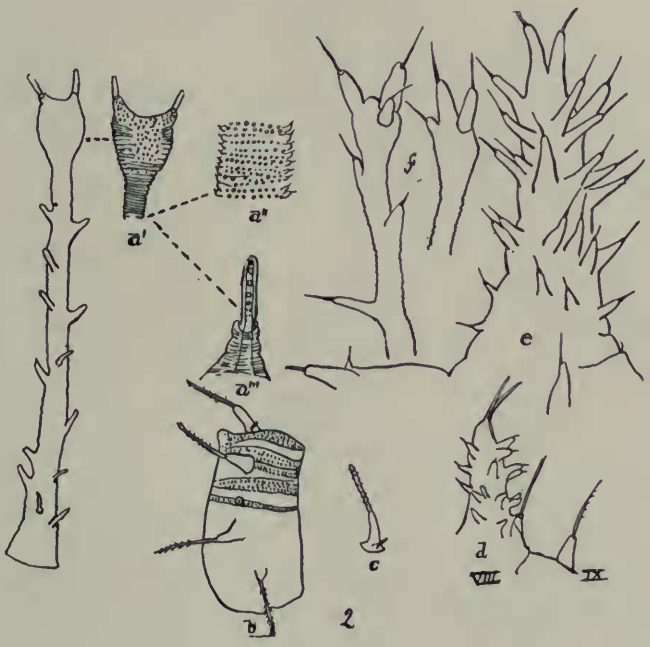
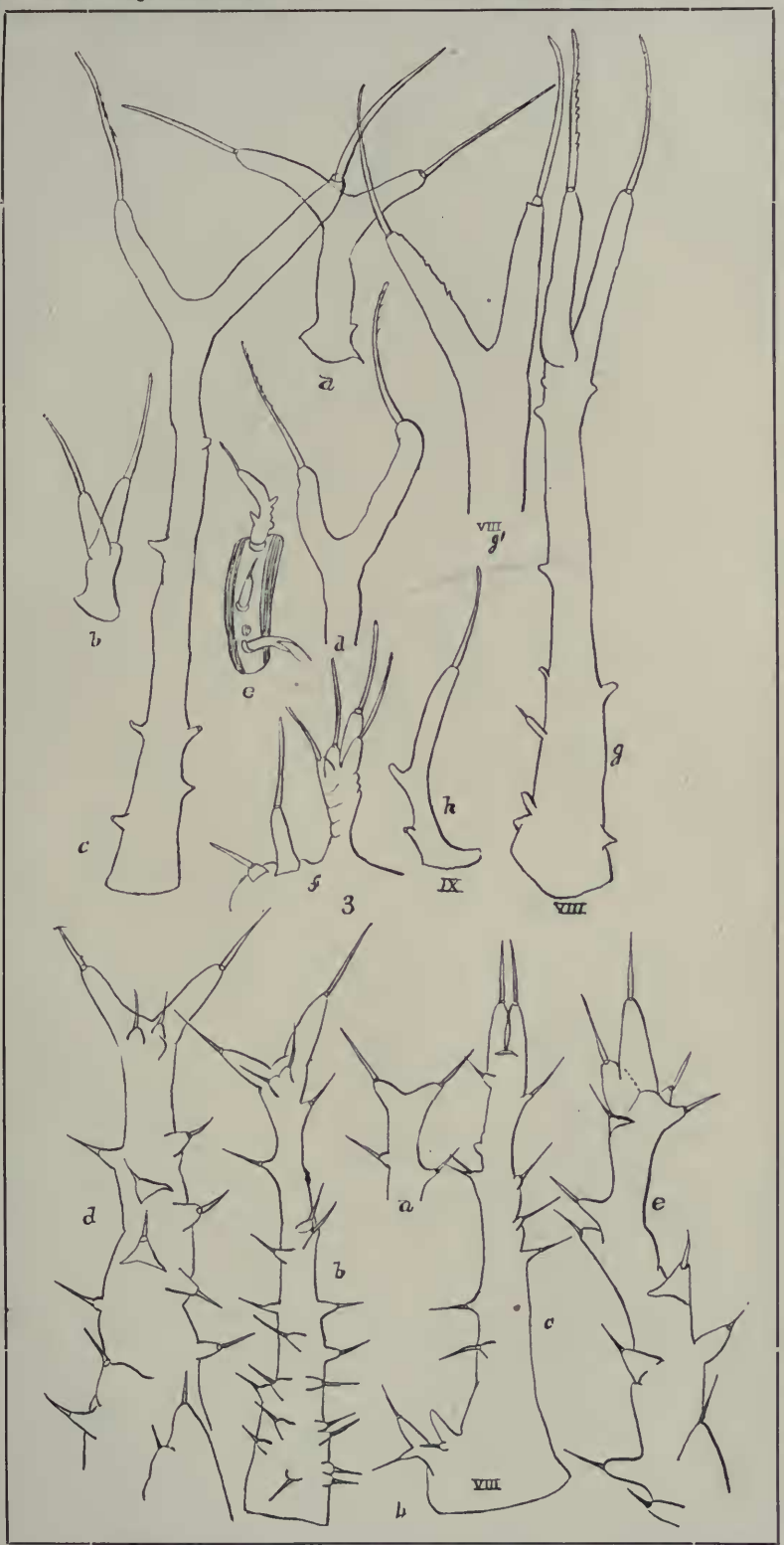


YOUNG LARVA OF DRYOCAMPA AND ARMATURE OF SPHINGICAMPA.



ARMATURE OF EACLES IMPERIALIS.

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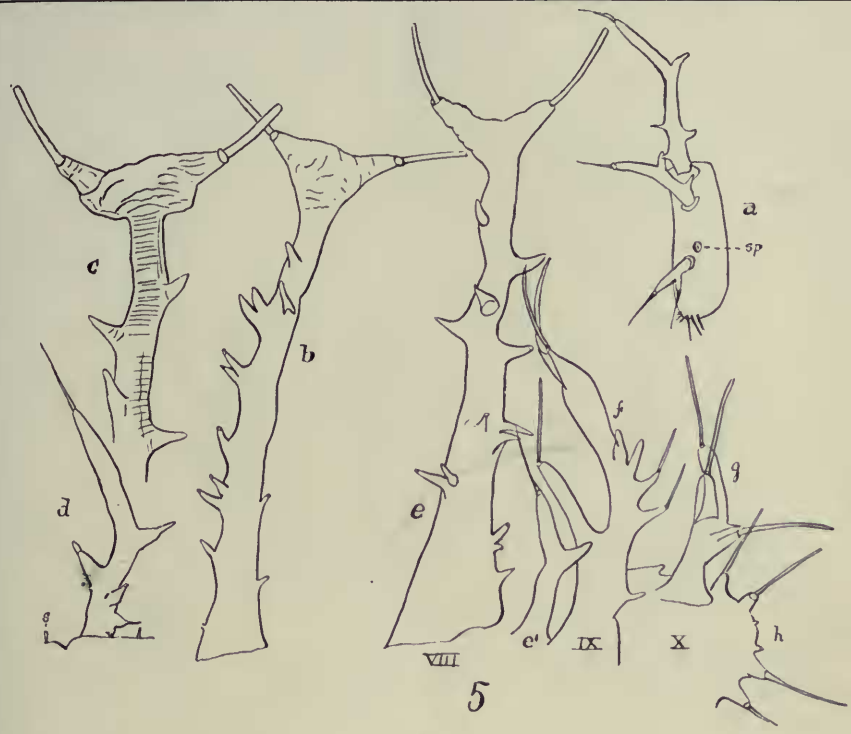
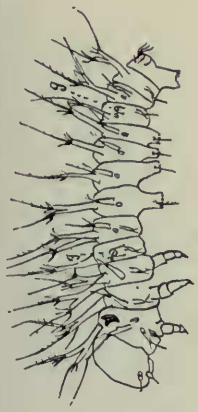
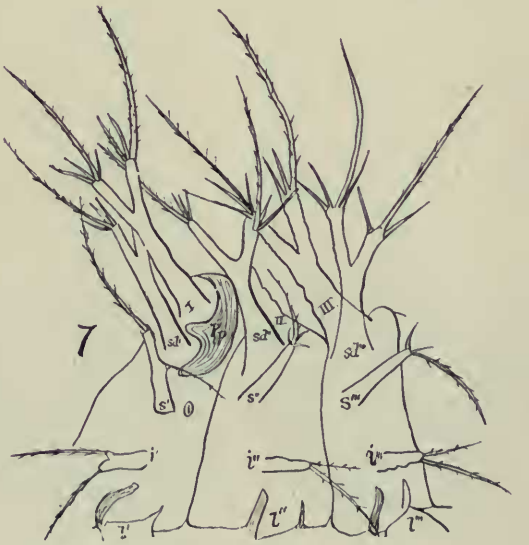
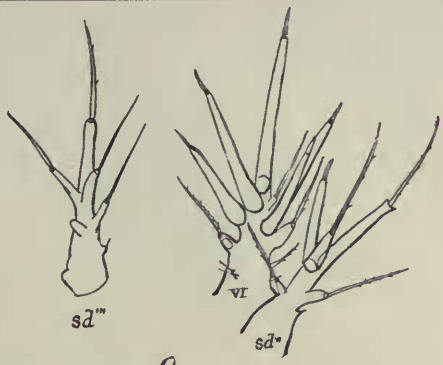






Armature of Citheronia regalis and of Hyperchiria io.



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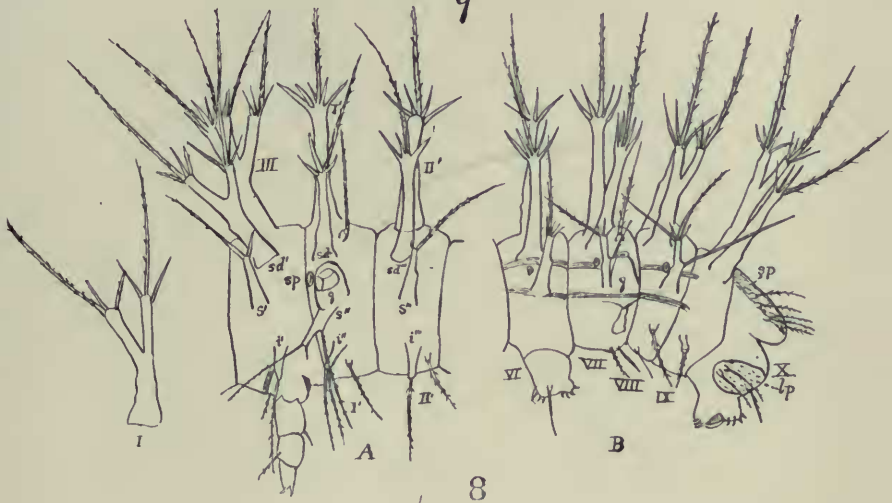

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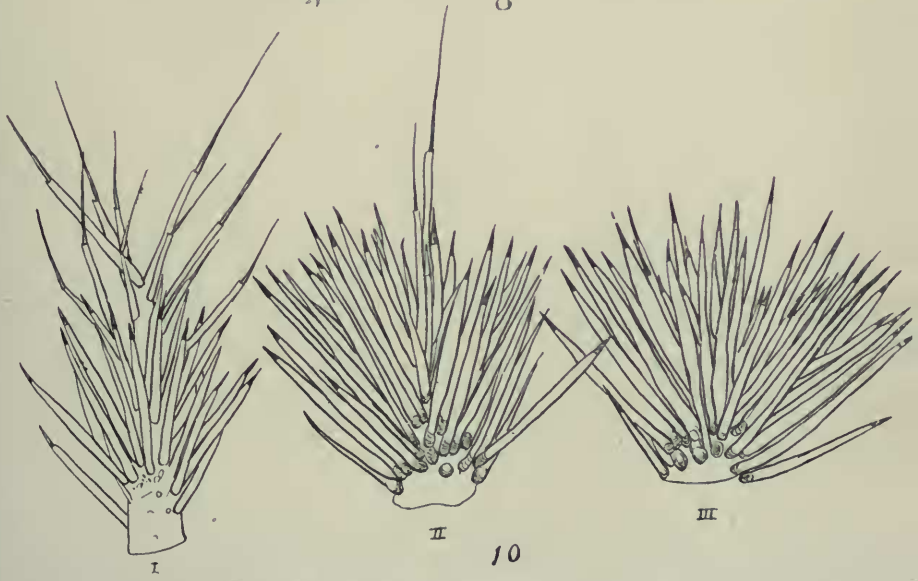

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Armature of Hyperchiria io.